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The REFINER

AND NATURAL GASOLINE MANUFACTURER

Edited Monthly at Tulsa, Oklahoma

GRADY TRIPLETT, *Editor* GEORGE REID, *Associate Editor*

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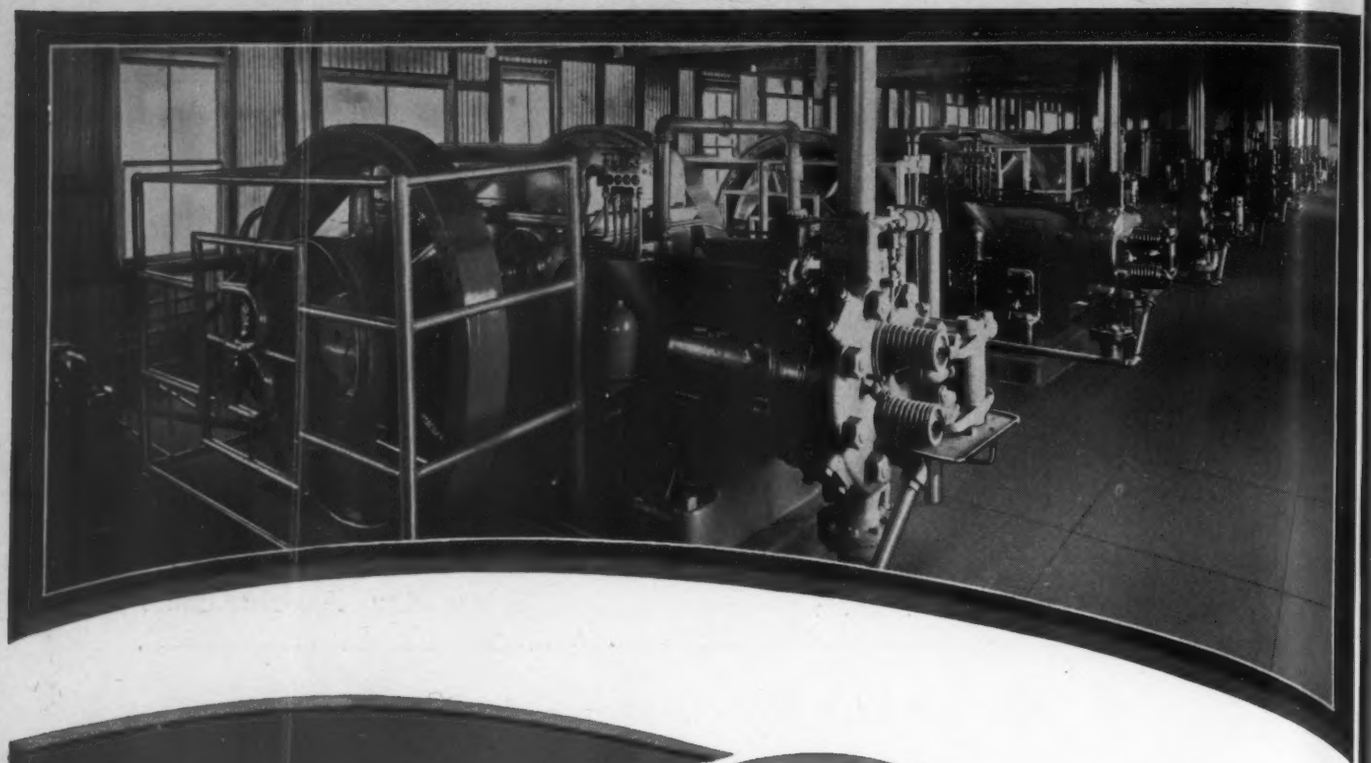

The photograph shows Barnsdall Oil Company's installation near Seminole, Oklahoma, which contains ten of the new Cooper Type-16, 50 H. P. gas engines direct driving compressors. This station was put into operation last year.

Ten of the New Cooper Type-16

This is one of the installations which has been demonstrating the merits of the New Cooper Type-16, 50 H. P. compressor units since last year. This is Cooper's response to the demand for a real good small compressor unit which could be used for boosting small quantities of gas or for small gasoline or air and gas lift plants. It is a four-cycle engine with still better fuel economy. A new method of direct driving the compressor cylinders results in a short compact unit requiring less space. It was the first engine of its size to use Timken main bearings. By changing the power liner and piston and replacing the magneto with an oil pump it can be converted to a full Diesel engine in the field. Any branch office can give you complete information.

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Good Habits

HABITS are not easily broken. On that score the refiners of the nation, especially those in the Mid-Continent, deserve praise for the way they have conducted their business on a rising market.

In past years runs were increased, often more rapidly than gasoline consumption increased. That had happened so often it had come to be a business habit. Other men in the industry laughed at the refiner. It was known that he would so manipulate plant throughput that he would defeat possible profit of increased consumption.

That has not happened this year. Perhaps the branding iron of the winter burned deeper than it did in other years. For some reason the old habit has been broken. The last quarter of 1927 and a part of 1928 witnessed a disastrous season for refiners. Gasoline prices hit a level which does not look good in print.

These low prices brought their reduction in plant activity. With the summer high consumption period at hand, it seemed certain that plant activity would rebound to equal demand, for that had happened in the past.

But the month of July witnessed in several instances the buying of gasoline when the buyer did not have plant output near plant capacity. These incidents and others are sufficient for a general compliment to the refiner of gasoline. He has kept and promises to keep his plant under control.

Another price situation is given credit for this determination to hold plant output down. Fuel oil prices are in somewhat the condition of gasoline last winter. So the reasoning is advanced that refiners are declining to make sufficient gasoline for immediate needs because they do not propose to sell fuel oil at a loss or to put it in storage.

Even in this, the refiner deserves his compliment. In past years he has not declined to dump gasoline at a loss and often to put it in storage at a loss. What he has learned from gasoline must be guiding in the control of fuel oil.

It is not true that each refinery is being operated on this ideal plan—to keep output just short of demand, so prices will allow profit. Doubtless there are refiners taking full advantage of the profitable condition the majority has created. They are charging stills to the limit and selling at a profit.

In the past, however, that has caused a stampede in the Mid-Continent. When one or two plants hit capacity runs, others followed, and still others, until output shortly passed demand and prices sagged. So far the actions of a few men have not determined the action of the majority. Men who can hold to a policy when they know others are profiting from it, deserve high praise.

If the determination of the past three months is maintained, the motoring season of 1928 will go down as a profitable period for refiners. The money made in that period will offset losses of six months previous.

What the refiner should do now is to make calculations for the winter. Present plant activity will not be profitable in December. It is possible for winter as well as summer to be profitable for the refiner. To be profitable, plant activity must be adjusted to meet economic conditions. The record of past winters is available for each refiner. Statistics afford him the guide for the capacity of his stills.

Having broken a bad habit, it is to be hoped that he will continue to break the old one from season to season until another one is formed. Let the new one be profitable.

Grady Tijlett

,,in an age of Specialization

We decided to specialize

The Fundamental Reason for the Gratifying Success of the Three Specialized Gulf Publishing Company Oil Journals

Our friends told us, when we decided to convert a successful general oil-industry publication, into **three** specialized oil journals that "we were taking a chance." But we knew we weren't. On every hand we had evidence of the trend toward specialization.

In architecture there were men who specialized in getting business, others who specialized in design, and others who specialized in the writing of specifications. In advertising there were copy specialists, layout specialists, media specialists. No longer was a man just "an engineer"—he was a **mining** engineer, a **power plant** engineer or some other specialized kind of engineer.

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These were the facts that gave birth, years ago, to THE OIL WEEKLY (for producers), THE REFINER, and THE PETROLEUM MARKETER. They express the characteristics that distinguish these papers from the general run of oil-industry publication. Each of the Gulf Publishing papers contains the basic news of the industry that the oil men want to know. Beyond that they have nothing in common. No reader, as one engineer puts it, "is forced to go through a lot of matter in which he is not interested in order to get to the information in which he is interested." No manufacturer is asked to advertise to marketers a product that appeals only to producers. There is 100% reader interest for the reader—100% value for the advertiser.

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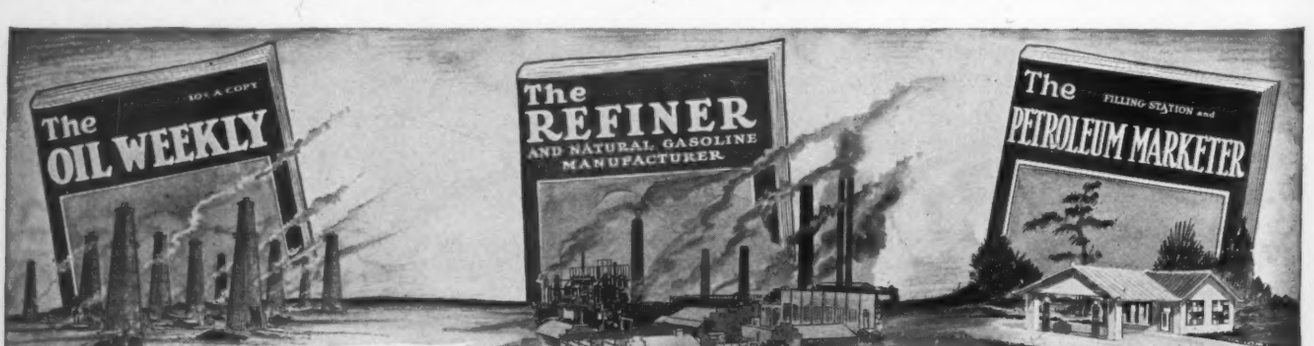

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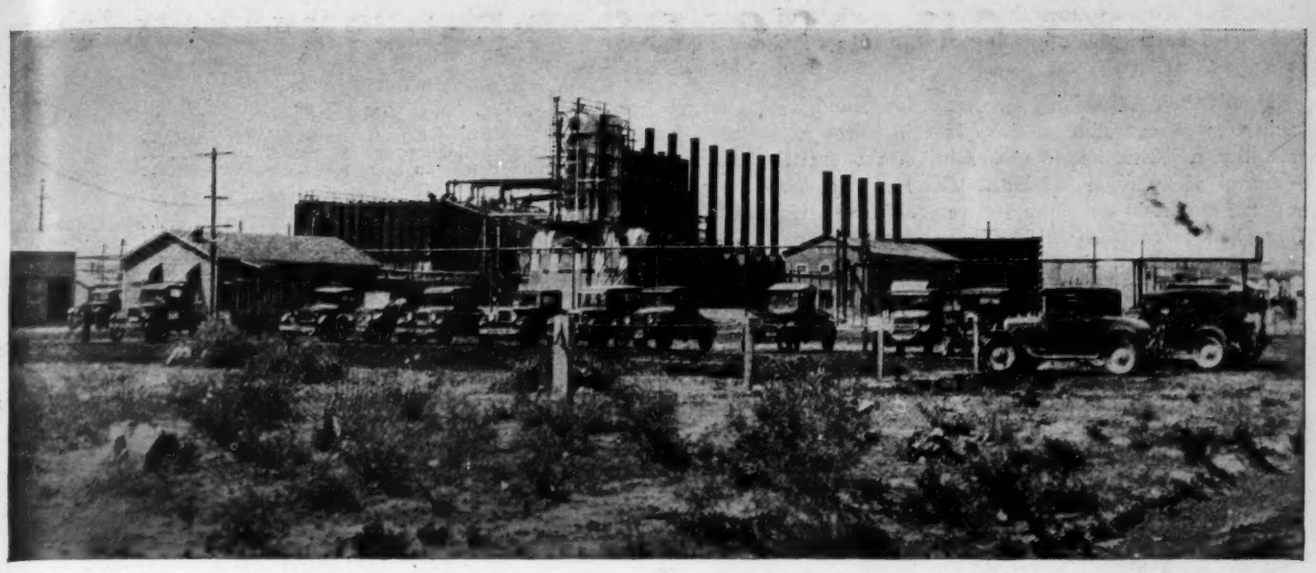


Humble Oil & Refining Company's 25,000-barrel plant at McCamey, Texas. Humble type internal fired stills and Humble type bubble towers.

West Texas Becoming Important Refining Center

By GEORGE REID
Associate Editor

OF the 15 refinery installations operating in the area which may be termed strictly West Texas, there are 10 new plants, two old ones which have been in operation for some time, one portable plant and two reconditioned plants which have undergone rebuilding since being taken over by new owners.

In the same area there are three new plants under construction and in the outlying districts such as San Antonio, Brownwood, Somerset and Laredo, there are seven refineries in operation and one building. The present status of this total number of 26 refineries in the territory mentioned, whether building or in operation, may be said to hinge upon the development of the large oil producing areas of West Texas.

In the majority of instances where new plants have been erected by refining interests entering the territory, the type of design and layout of equipment have followed the trend of modern refining practices. Plant operators have entered the districts with their plants some of which have rated capacities of 3000 to 5000 barrels per day, seemingly with much consideration given to the matter of salvage value of their equipment. Such a policy dictates that the refining equipment must consist of compact features which will lend to the ease of dismantling and transporting to perhaps other fields at some later date. This factor has influenced refinery design in the area to such an extent that shell stills, for example, are quite the exception. In addition to higher efficiency the modern tubular retort has the advantage of unit construction in such a manner that it may be dismantled with much higher salvage value than the shell still.

Quickly Dismantled

Other equipment, such as heat exchangers, dephlegmation columns, condensers, agitators, continuous treating systems, boilers and tankage, has been designed and installed for the most part, in such a manner that it may be quickly dismantled and shipped to a new location as easily as the original equipment was transported to its present site. The compact design of plant equipment lends itself readily to re-use in other districts at a later time and without great cost for labor and freight.

Photographs accompanying this discussion of a number of the West Texas plants are a striking contrast to the refinery of some years ago, and at first glance it might appear that the small plants are highly over-rated in capacity, until it is recalled that a three or four-inch pipe still operating in conjunction with a modern efficient bubble type tower will handle as much crude every day as quite a number of the old type eight by 30 shell retorts. With the exception of one or two installations, all of the newer plants in this area follow the modern design of tubular retort and bubble type fractionating columns.

In the treating department another evidence of the modern trend toward compactness and continuous operation is found in that at many of the plants the old type of batch agitator is absent. Continuous closed type treating sysems, predominate. Where the batch agitator is present the operators have placed in operation a system of circulatory treating whereby the gasoline being sweetened is not blown with air.

Humble Plant Largest

Humble Oil & Refining Company's plant at McCamey is the largest installation in the area. This plant is designed similar to other Humble Oil & Refining Company plants and consists of that company's type internal fired stills, eight in number, with individual stacks at the front of each. The stills vaporize into Humble type bubble type columns, some of

which are of the screen or finely perforated bubble plate type, and others follow the bell cap method of designing. The still battery is operating at the rate of about 25,000 barrels daily.

Humble Oil & Refining Company has found it necessary to acid treat its gasoline at this plant in order to secure color stability. Caustic and doctor solution are sufficient for the removal of hydrogen sulphide. The McCamey plant treats all of its gasoline in a modern and very efficient continuous treating plant of company design.

Another of the newer plants in the district which utilizes the shell still distillation system is that of the Wickett Refining Company at Wickett. This plant is located on the same large yard with the Blue Bonnet Oil Refining Company. The latter refinery was designed and constructed by I. B. Chittenden and is an example of the modern trend toward compact refinery units. It consists of a pipe still, small compact heat exchangers, chemical tile packed towers and tubular counter flow type condenser equipment. Between the exchangers and tube still there is a flash tower where a light cut is taken off as a result of the heating exchanged from the residuum. Leaving the flash tower the oil is then pumped through the pipe still and taken to the separator, which is equipped with a tile packed compartment at the top. The residuum is removed from the bottom of this tower. The vapor then passes into a bubble tower from which three streams are taken. Gasoline is removed overhead, kerosene from the middle and cracking stock or gas oil from the bottom. The plant operates under automatic control of temperatures and oil levels at the point where the second pump charges crude to the pipe still.

Three Plants at Pyote

Three plants in operation at Pyote, which is about 16 miles from the Hendrick field, in Winkler County, all follow the newer design, using tube stills and fractionating columns. The Tonkawa Petroleum Corporation, which is operated by the Constantine interests, consists of one tube still working in conjunction with three large towers of company design. Gasoline at this plant is treated to all standard specifications through a small home-made continuous treating system using sodium plumbite as a reagent.

The Pecos Valley Refining Company plant at Pyote utilizes the tube still and bubble tower in its operation. Doctor treatment of the gasoline by a semi-continuous method at the agitators secures the required results for this company.

At the third plant at Pyote recently placed in operation by J. D. Rather et al, a three-inch tube still is employed for heating. The oil is subjected to sufficient heat to cause the vaporization of all gasoline, kerosene and gas oil with one pumping. Leaving the pipe still, the hot oil is conducted to the separator placed near the base of the bubble tower and some distance from the tube still. Fuel oil is removed from the bottom of the separator and the vapors pass into the bottom of a large bubble tower. This tower was designed and constructed for the operators by the Southwestern Engineering Company, and is equipped with a Southwestern control section at the top. Condensers by the same manufacturer are used. The tower has 10 bubble trays in it and is equipped or designed for the removal of a "middle stream." Gasoline is taken overhead, a heavier naphtha from the center and kerosene distillate from the bottom. Both separator and bubble tower are located at some distance from the still as a safety measure and reduction of fire hazard. The plant construction and operation are under the supervision of A. V. Raplee, formerly of the McMillan Petroleum Products Company.

The product at this plant is treated by the lead sulphide method which is also used at the plant of the Sweetwater Refining Corporation at Sweetwater. This latter plant is described in more detail elsewhere in this issue. The lead sulphide treatment is giving good results at both plants. In the process being used, the gasoline is first given a preliminary wash with sodium hydroxide, caustic, to effect the removal of the hydrogen sulphide in solution. Instead of considering the resulting sodium sulphide as a waste product, this material is further utilized in the treating process by converting it with litharge, lead oxide, into lead sulphide—and this latter is used as a treating agent. As the sodium sulphide is removed from the agitator the litharge is added, allowed to settle, and then removed and washed. According to G. L. Rowsey of the Amarillo Refining Company, who is responsible for the lead sulphide method of treating, the reaction by which the lead sulphide is formed is probably as follows: $Pbo + 2NaOH = Na_2 Pbo_2 + H_2O$.

(As the Na_2Pbo is formed the following takes place:)

Na_2Pbo_2 plus $2H_2O$ plus $Na_2S = PbS$ plus NaOH. By using an excess of caustic in the preliminary wash there is an excess of caustic (sodium hydroxide) in the solution drawn off, which reacts with the litharge added to form sodium plumbite, which in turn reacts with the sodium sulphide to form lead sulphide. As the lead sulphide is formed, it is removed and washed, and then it is charged to the partially treated gasoline and completes the sweetening of the oil.

WEST TEXAS NATURAL GASOLINE PLANTS

Company—	Field Location—	Type	Cubic Foot Capacity	Daily Prod. In Gals.
Mitchell County				
Atlantic Oil Producing Company, Westbrook, C		..	230,000	160
The California Company, Westbrook, A		.....	1,000,000	2,800
Magnolia Petroleum Company, Iatan, Comp.		....	100,000	300
Howard County				
Magnolia Petroleum Company, Chalk, A		.....	2,000,000	1,200
Reagan County				
Big Lake Oil Company, Big Lake, A		.....	10,000,000	16,500
Signal Gasoline Company, Big Lake, A		.....	14,000,000	10,000
Winkler County				
Humble Oil & Refining Company, Hendrick,A		....	20,000,000	Bldg.
Crane County				
Phillips Petroleum Company, McElroy, A		.....	50,000,000	Bldg.

WEST TEXAS REFINERY SURVEY

Refining plants operating in the West Texas district are listed below by companies, including plant location and daily capacity:

Company—	Location	Capacity in Bbls.	Current Crude Runs	Crude Source
Humble Oil & Refining Company, McCamey	.....	20,000	15,000	Mixed grades
Pasotex Petroleum Company, El Paso	.....	10,000	3,000	Hendrick
J. S. Cosden & Company, Big Springs	.....	*10,000	...	Chalk-Roberts
Coltex Refining Company, Colorado	.....	8,000	7,000	Chalk-Mitchell
Burford Oil Company, Pecos	.....	*5,000	...	Hendrick
Blue Bonnett Oil Refining Company, Wickett	.....	4,000	3,000	Hendrick
Tonkawa Petroleum Corporation, Pyote	.....	5,000	3,000	Hendrick
Pecos Valley Refining Company, Pyote	.....	3,500	3,200	Hendrick
Midland Refining Company, Midland	.....	2,500	1,500	Hendrick
Rio Grande Oil Company, El Paso	.....	2,500	2,500	Hendrick&Wheat
Wickett Refining Company, Wickett	.....	2,500	800	Hendrick tops
Amarillo Producers & Refining Corporation, Pyote	.....	3,000	1,000	Hendrick
San Angelo Refining Company, San Angelo	.....	2,000	1,000	McCamey
Big Springs Refining Company, Big Springs	.....	*1,500	...	Chalk-Roberts
Big Lake Refining Company, Big Lake	.....	*1,000	...	
Odessa Refining Company, Odessa	.....	600	SD	Hendrick
Sweetwater Oil & Refining Company, Sweetwater	.....	1,200	800	Mixed grades
R. S. Allen et al, Big Spring	.....	†5,000	...	Chalk-Roberts
Total	.....	87,300	41,800	

(*) Building.
(†) Proposed.

Sulphur Crudes Fast Losing Bad Reputation

In addition to not being as bad as they smell, West Texas crudes have value in anti-knock gasoline quality to offset other objections

By GEORGE REID
Associate Editor

CRUDE oils produced in the various fields of West Texas have come "into their own." With increased use by an ever increasing number of refiners these so-called "sour" crudes are by sheer merit, offsetting and discounting the evil reputation which preceded their present wide distribution.

It will be recalled that the oils from Mexico, then Mexia, and Smackover, and later the Panhandle crudes, were subjected to the same adverse criticism and ill repute because of their sulphur content or because of the presence of some hydrogen sulphide gas. West Texas crudes, because of their higher content of hydrogen sulphide, were generally classified as the "worst yet," despite the fact that the mere presence of hydrogen sulphide in a larger percentage than occurred in other oils offered but little difficulty of removal or handling to the refiner who had experience with other crudes of a similar type.

Refinery Yields

The refinery processing systems secure the usual list of products from the West Texas oils, including gasoline, kerosene, fuel oil, and some of the crudes yield lubricating oil cuts in quantities ample to justify their manufacture. Gas oils, engine and stove distillates, and overhead fractions for charging to the cracking units are available. Cracking the fuel oil presents little difficulty. Skimming plant recovery averages from 25 to 30 per cent straight run gasoline, with recoveries reported as high as 60 per cent. when the gas oil and fuel oil are subjected to the cracking operation.

In addition to the present distribution of the crudes throughout the refinery districts of the United States, another indication of the acknowledged valuable characteristics of the crude lies in the fact that almost weekly there is announced new projects, or improvements in present systems, for larger facilities for handling the production of the fields and transporting it to the large refining centers. The popularity of the Yates and Hendrick fields production and the increased demand for the oil from these fields is traceable to the fact that the gasoline content of the crude is of relatively high anti-knock value. Some refiners report that gasoline derived from Hendrick crude has a 42 per cent. benzol equivalent. This quality lends itself admirably to the policies of the major refining interests who are wide distributors of anti-knock, or premium grade, motor fuels.

West Texas Plants

Refining interests have taken their equipment to the source of crude supply with the result that West Texas is now generally classified as a separate refining district. With 20 plants in operation and five building, the district assumes the importance of a one hundred thousand barrel refining center. Two or three more large projects are being formed which will swell the daily capacity to perhaps 125,000 barrels by the end of the year. Low priced crude oil has been contracted for in many instances for the balance of the year with some contracts extending over 1929. Most of the smaller plants and some of the larger installations are making a specialty of fuel oil and operating primarily as topping plants. The resulting daily production of gasoline is finding its way to market as far north as the Canadian boundary and as far east as Ohio. The largest refiner in the area at present is Humble Oil & Refining Company with its 5000 barrel plant at San Antonio and its plant at McCamey, where 25,000 barrels were being topped daily last week with plans to increase to 30,000 barrels per day.

Little Refining Difficulty

A recent visit including inspection of the majority of plants operating in the West Texas district disclosed the fact that these operators were experiencing little difficulty in the preparation of their products in so far as corrosion of equipment and the quality of the products is concerned. The chief difficulty is one of desulphurization and this problem is not one of a serious nature, as hydrogen sulphide is, in most cases, the source of trouble. The desulphurization of the gasoline is easily accomplished through the use of the common chemicals generally employed for treating purposes.

Some refiners are of the opinion that over a long stretch of time the processing of the crudes of this district will require more equipment through wear and tear than would be refining of a like amount of "sweet" crude. On the other hand, other refiners state that by the usual neutralization methods the life of their equipment will be prolonged to compare favorably with experience in refining sweet oils. Neutralization with soda ash or caustic in the stills is practiced and seemingly attended by marked success. Reagents injected into the fractionating columns such as ammonia, and into the vapor lines, tends to retard the corrosive action of the moist hydrogen sulphide gas and to materially lengthen the life of condensing equipment. Several operators processing crudes from these fields have found that chemical treating is made much easier and corrosion materially checked through the use of water spray systems installed in the dephlegmators or special washing towers, where the rising gasoline vapors are scrubbed free of the corrosive gas prior to condensation. Others water-wash the gasoline after condensation, and some employ weak alkaline solutions instead of pure water.

Naturally, there is some corrosion in the manufacturing processes and systems just as there is in the refining of practically all crude oils, but the general opinion among refiners operating on the West Texas oils is that with the proper care and attention and the use of the usual chemicals for neutralization, the corrosion may be checked to a large extent and at very little additional cost.

Make Good Gasoline

Among the refineries visited not one reported any unusual difficulty in the preparation of gasoline meeting all specifications as to color stability, odor, doctor test, and corrosion, although practices in chemical treating differed with the various operators. As previously stated, this important step in refining is dependent to a large extent upon the type of distilling and fractionating equipment. A number of plants are meeting

(Continued on page 62)

Gasoline Extracted From Sulphur Contaminated Gas

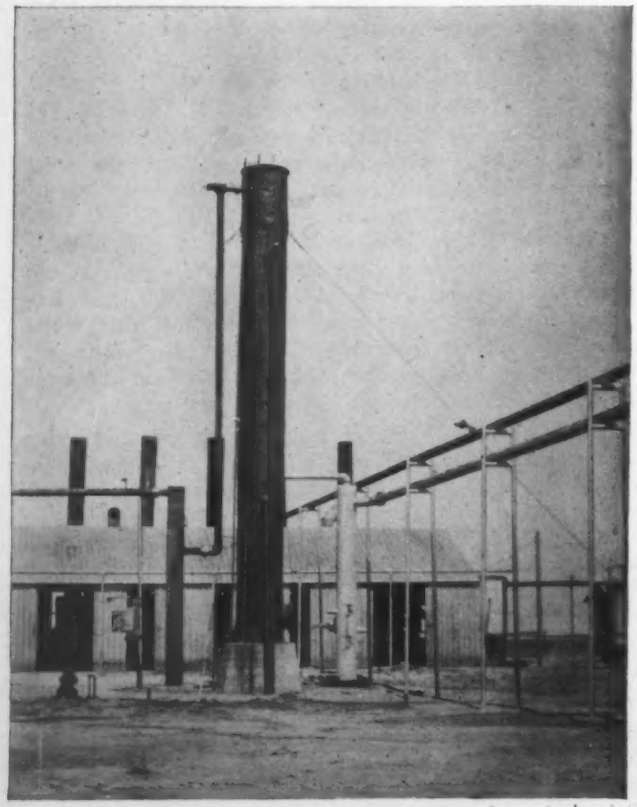
Hydrogen sulphide presents double problem of special treating and combatting of corrosion, which are met in Big Lake plant

By GEORGE REID
Associate Editor

EXTRACTION of gasoline from natural gas bearing eight to ten per cent. hydrogen sulphide is the problem confronting the operators of the Big Lake Oil Company absorption natural gasoline plant at Big Lake, Reagan County, Texas.

This plant, which is processing an approximate four million cubic feet of gas rich in hydrogen sulphide with a gasoline recovery of about five gallons per 1000 cubic feet, must pass around 400,000 cubic feet of this corrosive and more or less poisonous hydrogen sulphide gas through its absorption equipment each day. In the same field like conditions prevail with the operators of the Signal Gasoline Company plant. Incidentally, until completion of Humble Oil & Refining Company's absorption plant, which is building in Winkler County in the Hendrick field, the two plants of the Big Lake and Signal Gasoline Companies comprise the vanguard of the natural gasoline manufacturing industry in the whole of the West Texas oil producing area.

With the unusually high percentage of hydrogen sulphide production along with the natural gas from the Big Lake field the major problem in gasoline plant operation is one of combatting corrosion and the production of gasoline meeting all of the current standard specifications. This condition of high "sulphur gas" content has contributed much to the hesitancy of the gasoline manufacturers to enter the district despite the comparative richness of the gas in gasoline content. There are six gasoline plants operating in the West Texas fields, with one building, as mentioned above. The success of these pioneers in treating "sour" gases of the area is leading to the installation of more gasoline plants in the other fields, and it is safe to predict that in the not far distant future West Texas will take a prominent place as a gasoline producing district just as it has assumed importance as a petroleum refining district.



Dephlegmator of company design at Big Lake Oil Company's plant. Boiler house in background.

Absorption and Recompression

At the plant of the Big Lake Oil Company natural gas from the field is boosted to absorption plant operating pressure of 20 pounds through three 165 horsepower Bessemer gas engine driven compressors. Because of the corrosive nature of the gas, it is necessary to extract the hydrogen sulphide in that portion of the gas used for fuel in the gas engines. The treating plant cleans up sufficient gas for home consumption at the company's large camp, and for use in the field where in a few instances gas engines are used instead of electric motors for field operations, in addition to the gas used by the plant machinery. Gas from the field to the compressors is scrubbed in the usual manner.

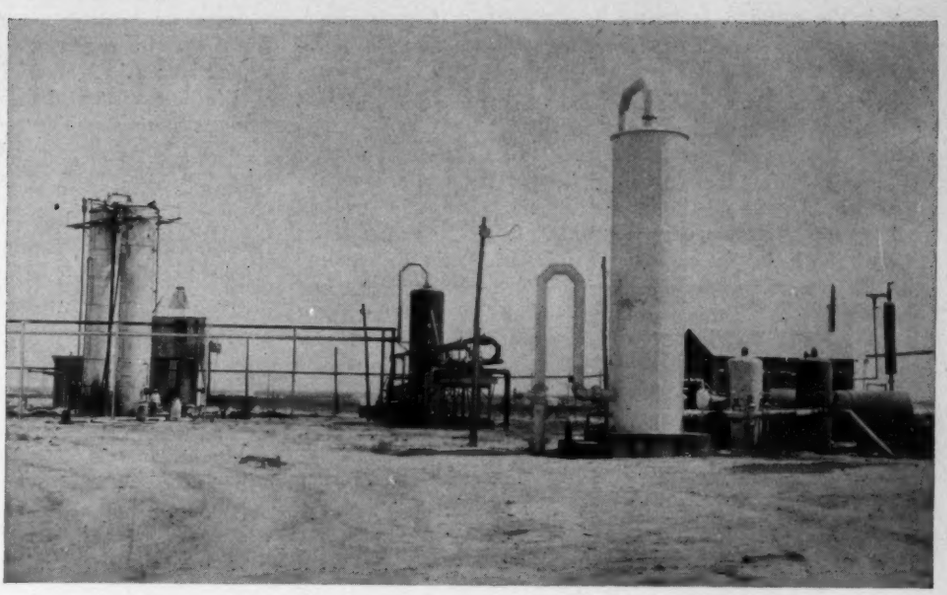
Leaving the compressors the gas is cooled and passes through the absorption plant. A Campbell Oil Froth absorber, size 6 by 24 feet, is handling all of the gas treated by this plant and extracting the approximate average of five gallons per thousand. Oil circulation through the system is at the rate of 180 gallons per minute. It is planned to increase the gas throughput sufficiently to increase gasoline production to around 30,000 gallons daily in the near future. A Goulds centrifugal three-stage, five-inch pump is used in the circulation of lean oil, while a four-inch two-stage pump of the same type circulates the fat oil. These pumps are electrically driven by Westinghouse 25 horsepower motors.

Leaving the absorber the enriched oil passes through a heat exchanger of company design. This exchanger system effects an increase in the temperature of the fat oil to about 280 degrees. Lean oil leaving the Southwestern distillation unit which is held at a temperature of 300 degrees by live steam, after passing through the exchanger is lowered in temperature to 180 degrees. From the exchangers the enriched oil passes through a series of Braun preheaters and into the Southwestern still. Despite the corrosive nature of the gas and gasoline vapors handled, this equipment is functioning satisfactorily and without serious damage to the present time.

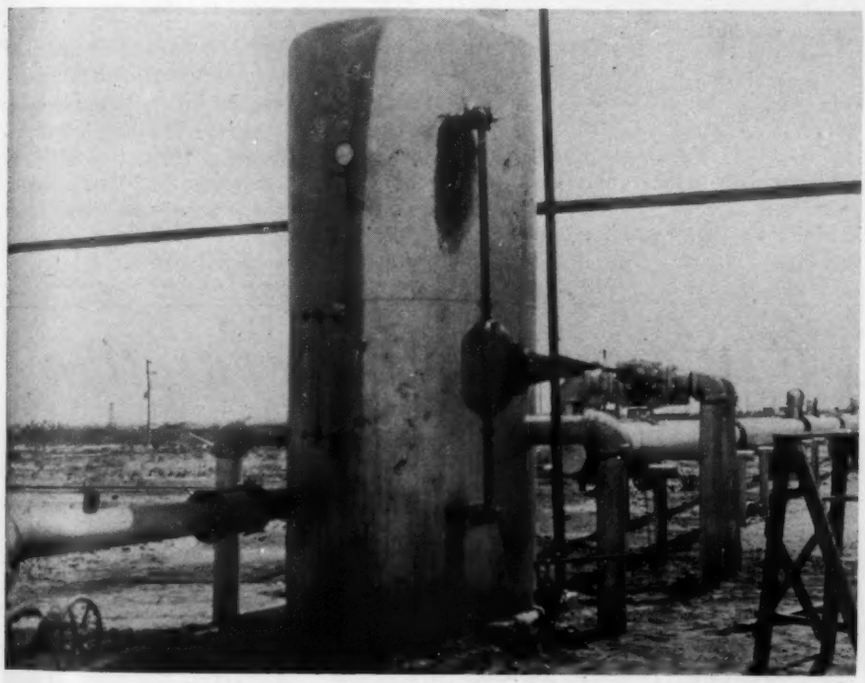
Gasoline vapors from the distillation system are conducted to a dephlegmator of company design. This equipment, together with many other devices about the plant described in this discussion, was designed by the plant superintendent, L. C. Thompson, to meet the peculiar operating conditions in this field. The dephlegmator consists of a well insulated tower equipped with 100 two-inch vertical tubes, through which the gasoline vapors flow upward, and which are surrounded by water circulated in sufficient quantity, under automatic control,

to maintain a constant temperature of around 218 degrees. In the dephlegmator the entrained absorption oil and much of the water resulting from distillation with live steam, is separated and conducted to an oil-water separating tank. The oil is returned finally to the absorption system.

Vapors from the dephlegmator pass through the cooling coils and accumulator tanks. At this point the uncondensed gasoline vapors are subjected to recompression process for the recovery of tail gas gasoline. Approximately 60 per cent of the entire make of the plant is derived from the absorption system. The remaining 40 per cent. is produced through the recompression method. Six 70-horsepower Bessemer gas engine driven compressors are employed in recompression work. Four of the smaller machines are employed for low stage compression, taking the vapors from the first gasoline accumulator tank and compressing it to 60 pounds. After compression the vapors are discharged to cooling coils and accumulator tank. From this tank the remaining uncondensed gases or vapors are passed through one high stage compressor and compressed to 175 pounds pressure, discharging through cooling coils and into a third accumulator tank. Uncondensed gases from this tank are vented through a safety valve back into the boiler fuel gas line and consumed. The remaining compressor is employed only as an auxiliary machine.



General view showing absorber, and distillation equipment at Big Lake Oil Company's natural gasoline plant in the Big Lake field.

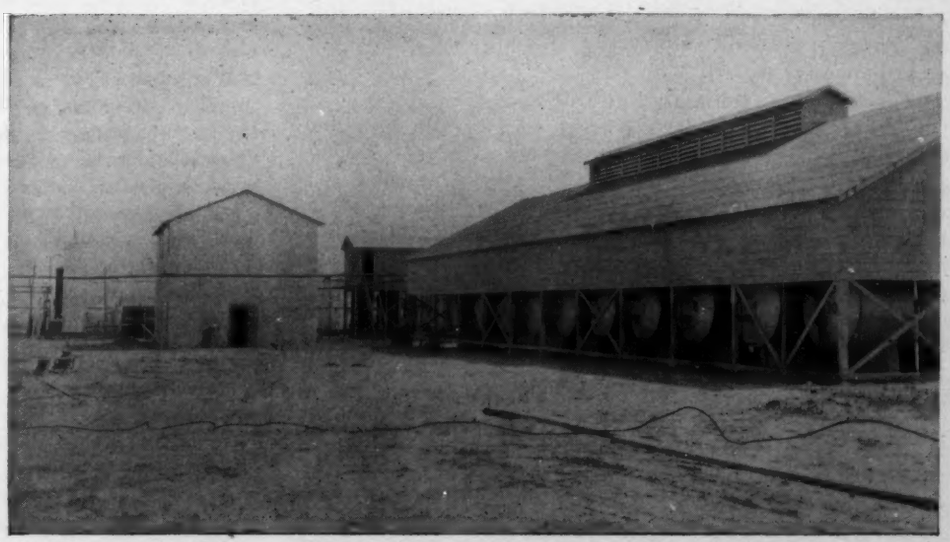


Close-up of exchanger equipment showing type and design as described.

The three fractions of gasoline accumulating in the tanks as the result of absorption and compression are then blended together into one fraction through a stabilizer. This gasoline meets the specification of Grade BB.

Treating Gasoline

No definite figures as to the content of hydrogen sulphide in the gasoline produced by the plant were available at the time of the writer's visit. The incoming gas indicates the presence of the sulphide averaging from eight to ten per cent. The residue gas leaving the absorption plant shows an increase of hydrogen sulphide to 11 and 12 per cent. on an average. The gasoline produced is rich enough in sulphur compounds to cause the accumulation of free sulphur at the stabilizer where leaks occur, for example. With the high percentage, however, of hydrogen sul-



View of gasoline storage tanks. Metal building in center houses continuous chemical treating plant as described in text.

phide in the gasoline, estimated by one operator to be seven to eight per cent.,—the chemical treating of this product is of interest.

The treating plant consists of eight treater columns in continuous hook-up, housed in an all metal building. The gasoline is taken direct from the accumulator tanks after stabilization and pumped through the treating plant. The first two of the towers are partially filled with a 16 Baume caustic solution, and in these towers, equipped with finely perforated baffle plates most of the hydrogen sulphide is removed by the sodium hydroxide. Pumps are provided for circulating or removing and renewing of the chemical as required. In the next two settling or treating towers the gasoline is washed in intimate contact with water. The fifth and sixth towers are equipped with perforated plates and hold the solution of sodium hypochlorite used as a sweetening agent at a constant level. Gasoline leaving these towers is then conducted to the last two settling drums in the series where it is again washed with water. This system of treatment results in the pneparation of doctor sweet and non-corrosive natural gasoline with 30 plus color and stable in sun light. In regard to the equipment used, experience has shown that the perforated plates used to secure intimate contact between chemical solutions, and gasoline have a longer life than orifice plates such as are commonly used in incorporators or mixing devices installed outside of the treating columns. With the large treating columns equipped with the plates, very good results are secured so far as the actual treating of the oil is concerned.

Treating Drums Corrode

The corrosive agents do attack the treating drums with the result that they have not been very long lived. Experiments are now under way at the plant involving the lining of those drums or treating columns where the corrosion has been most severe, with concrete. Two of the drums are in service lined with a four-inch shell of concrete, and indications point to very favorable results since the two drums in question have been in continuous service for about six months.

Another item of importance contributing to the difficulty of plant operations in this district is the hardness of the water. In addition to an approximate 65 grains of hardness, the water bears some sodium chloride. A chemical treatment consisting of soda ash and lime is successful in reducing the hardness to about 2 grains, for boiler use. The salt must be taken into the boilers.

Loading With Compressed Air

Gasoline finished and treated is stored in the usual manner and handled as it is commonly handled in other fields. At the Big Lake plant, however, loading is accomplished with compressed air instead of gas pressure, for the reason that the gas is so contaminated with hydrogen sulphide that its use would throw the gasoline off specification. A small Ingersoll-Rand Imperial type 20 compressor is motor driven by a 15 horsepower Westinghouse motor and the pressure built up by the compressor is used to "push" the gasoline from storage tank to loading rack. As a safety guard against static electricity, a six-foot section of the dicharge line, and just outside of the small compressor building, is made of hard rubber hose. The motor, lines, etc., are all grounded. There is danger accompanying such loading practice which is recognized by the plant operators and they have taken every precautionary step available to offset such hazards as exist and are known. The method, however, has been in service for several months and has proven safe.

Sulphur Crudes Fast Losing Bad Reputation

(*Continued from page* 59)

specifications through the use of a simple sodium plumbite or doctor treatment. One or two operators are employing the lead sulphide method of treatment and a few are acid treating the motor fuel. In no instance was a refinery resorting to redistillation. The tube still method of distillation is by far the most popular, used in conjunction with the latest types of efficient bubble towers. In addition to meeting the accepted standard specifications the majority of West Texas refineries processing crude from Yates and Hendrick fields are producing straight run gasolines of relatively high benzol equivalent or anti-knock properties.

Refining Not Difficult

Refiners have found the oils much less difficult to refine than was expected. Likewise the manufacturers of natural gasoline are entering the districts where gas is available and they, too, find that the difficulties heralded with regard to their processing systems are not insurmountable. While the natural gas production from the pools is high in hydrogen sulphide content, the gasoline content is also unusually high.

Operators in the Big Lake pool report that natural gas from that field contains from 8 to 13 per cent. hydrogen sulphide by volume, with a field average of approximately 10 per cent. and some individual wells running as high as 20 per cent. H_2S.

Gas from the McCamey field is reported with a 6 per cent. hydrogen sulphide content, and the Church-Fields-McElroy field produces gas containing H_2S in such proportions as 8 to 12 per cent.

Such conditions have tended to retard the development of the natural gasoline industry in the West Texas area and there are but five plants operating and one building. Those plants which are extracting gasoline from the contaminated gas have had sufficient experience in desulphurizing the gasoline and the fuel gas for their engines that they feel certain that the most serious problems of corrosion of equipment have been solved.

Natural Gasoline

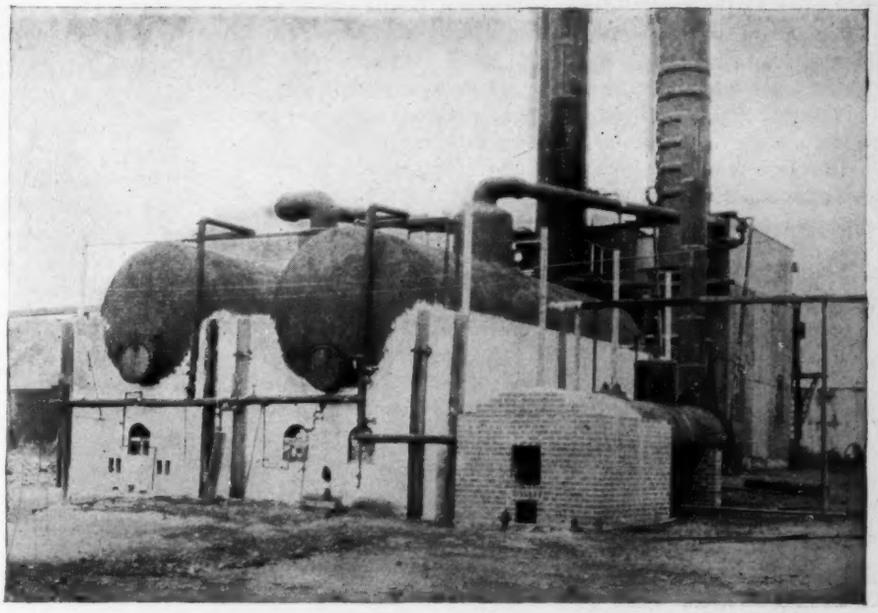
The Big Lake Oil Company, for example, operating its plant at about 5,000,000 cubic feet of gas daily, is extracting approximately five gallons of gasoline per thousand cubic feet. In the same field the Signal Gasoline Company is operating its absorption gasoline plant with very little difficulty. The practice at the Big Lake plant consists of compressing the incoming gas to plant operating pressure of 20 pounds, passing it through a Campbell absorber to extract the gasoline. The uncondensed gases from the distillation system are recompressed and the gasoline extracted. The combined production is then stabilized and treated in continuous treaters with caustic wash and sodium hypochlorite, making a finished product of grade BB, doctor sweet, non corrosive, and stable in color. It is necessary, at the West Texas gasoline plants to treat the gas used for fuel for the engines with soda ash for the extraction of hydrogen sulphide. The Koppers method is extensively employed for this purpose and for treating gas for camp and field consumption. There is little doubt but that the gasoline manufacturing phase of the industry will expand with the solution of such problems, just as the refining industry has expanded in the use of West Texas crudes since experience has shown that the evil reputation incurred by these oils was not justly deserved.

Sweetwater Plant Operation Minimizes Sulphur Trouble

Gasoline recovered is low gravity and is blended with natural gasoline from Big Lake field, yielding an anti-knock product

WHEN the Sweetwater Refining Corporation was organized some weeks ago through the purchase of the old Sweetwater Refining Company's skimming plant at Sweetwater, Texas, the old still battery and fractionation equipment were immediately repaired and reconditioned, the work including installation of bubble type towers especially designed for the close fractionation of gasoline and kerosene from the crude oils from Winkler and Crane Counties.

The old plant had not been in continuous operation for some time and it was necessary to repair much of the old equipment as well as to improve the processes by the addition of preheating equipment as late type bubble towers. These latter were designed and installed by J. T. Miller, who is in charge of plant operations. Except for certain improvements, the new towers are very similar in design to those installed by Mr. Miller at the Burkburnett, Texas, plant of the Noble Oil & Gas Company, early in 1924, where the bubble type column was pioneered in the North Texas area. The latter installation was described in detail in this publication of August, 1927. The same type of tower at Sweetwater, designed for the particular crude to be distilled has in a large measure contributed to the increase in daily through-put and capacity rating of the plant, increasing it from a 500-barrel plant to a 2000-barrel plant, with the use of the original two shell stills. J. A. Johnson, refinery engineer, formerly of Tulsa, is manager of the new company.



Sweetwater Refining Corporation's skimming plant running on Winkler and Crane County crudes at Sweetwater, Texas. Showing details of preheater and bubble towers. Suspended flume for gravity flow of water from condenser boxes to cooling tower shown at extreme left.

Among the improvements made in equipment at the plant is that of a home-designed water cooling system patterned after others of the same type which the plant superintendent has installed for certain other companies. Through this system the cooling water for the condensing coils is handled by gravity flow from the boxes and cooled without the use of a pump for spraying. The cooling pit is located about 300 feet from the condenser boxes, and from the point where the water overflows from the boxes, it is conducted to the cooling pit by means of an open wooden flume. Flowing through this open trough the water is cooled to a certain extent before it reaches the cooling pit. The flume is suported above ground by means of welded supports made from old scrap pipe about the refinery yard.

At the point where the water spills from the flume it is caused to become separated into a number of very small streams and to spread out over a relatively wide area at the top of a baffle-like tower, where it trickles downward to the pit over the baffles and is cooled in the descent. The temperature of the cooling water is kept sufficiently low in this manner to afford streams in the receiving house which never reach a temperature higher than 90 to 95 degrees even during the summer months. With this system of gravity and open flow but one pump is required for water circulation. A centrifugal water pump located at the cooling pit, pumps water to the boxes for cooling purposes.

Preheater

Since the plant was designed originally to operate on the batch system, no equipment for heat interchange was present when the new operators assumed control. The superintendent of operations has lately installed a preheating device which consists of an old horizontal return tabular boiler equipped with a six-foot dutch oven. Crude charged to stills first passes through the shell of this preheater, and is raised in temperature to about 300 degrees. A very low fire is required for this preheating and the heat is imparted to the oil through the walls of the tubes in the boiler.

From the preheater the oil is conveyed to the first shell still, where a very gentle firing raises the temperature sufficiently to vaporize all of the gasoline fraction, about 25 per cent of the crude. The volume of oil distilled in this shell still is to be further reduced by the installation of a separator or flash chamber between the preheater and the still, in the near future. The lighter vapors removed by the preheating system will be taken into the first bubble tower along with the gasoline vapors derived from the first shell still. At present the reflux material or condensate accumulating in the first bubble tower is conducted back into the No. 1 shell still. The second shell

still is utilized for the vaporization of the kerosene and gas oil fractions. The old still setting was badly cracked due to exposure, but air infiltration was eliminated through the application of a relatively thick coating of a mixture of lime, cement and sand, after which the fuel requirements were materially decreased.

The second fractionating column, also of bubble type, is to be redesigned so that kerosene will be taken overhead, a stove or engine distillate removed from the central portion and gas oil from the bottom—or a heavy special naphtha will be removed overhead with corresponding change made in those cuts coming off below. These towers give the small plant the desired flexibility, so that a number of products may be distilled in continuous operation. The shell stills are 8x30 feet. These dimensions give some idea of the value of efficient fractionating equipment when it is recalled that the two stills are handling a daily through-put of approximately 2000 barrels.

Gasoline from the Winkler County production is low in gravity, running around 52/53 degrees A. P. I. with about 420 end point. This product is blended up with natural gasoline from gasoline plants in the Big Lake field. Both straight run and natural gasoline are valuable from an anti-knock standpoint, and plant operators claim that their gasoline has an anti-knock value of around 40 per cent. benzol equivalent. The gasoline is chemically refined by the lead sulphide method, using equipment of semi-continuous design so that no agitation by blowing is required—thus materially decreasing evaporation and handling losses. This gasoline has a 30 plus color and is guaranteed to be unaffected by direct sun light for eight hours. The company distributes its motor fuel by truck to retail stations through the district immediately surrounding the town of Sweetwater and to a number of stations in the city under the brand name of "Lily White."

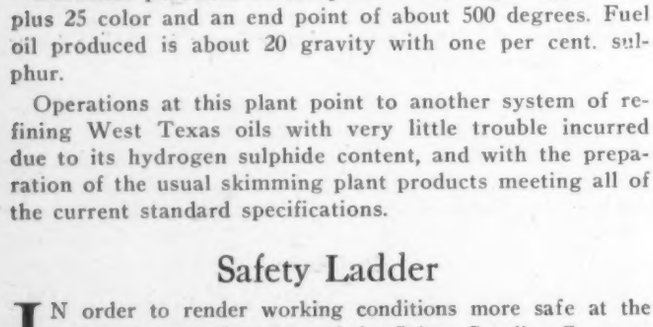
Kerosene produced at the plant is 41/42 gravity, with a plus 25 color and an end point of about 500 degrees. Fuel oil produced is about 20 gravity with one per cent. sulphur.

Operations at this plant point to another system of refining West Texas oils with very little trouble incurred due to its hydrogen sulphide content, and with the preparation of the usual skimming plant products meeting all of the current standard specifications.

Safety Ladder

IN order to render working conditions more safe at the absorption gasoline plant of the Coltex Gasoline Company at Fairbanks, Louisiana, the operators have installed safety devices of the latest approved type throughout the entire plant.

No piece of machinery or moving equipment is without its safety guards at this plant. Safety is practiced by the workmen and operatives and new men are taught the methods of working at the plant as followed by the foremen and supervisors, which is in accordance with the safety code of the company.



These ladders make workmen more safe.

The accompanying photograph illustrates one method of making equipment safe. This horizontal steam still and the preliminary condenser back of it, is made safe by means of ermanent steel walkways at the top, and with the approaching teps leading to the valves at the top of the still and the vapor condenser, made of heavy corrugated steel plate, supported by structural steel and angle iron frame work. Guard rails and toe rails above the walkway platforms prevent the workmen from falls. A number of electric lights are provided above the walkway to guide the workmen when periodic inspection is required during night hours.

This safety-ladder and walkway replace the old method of approach which consists of slender wooden ladders leaning against the side of the still, by means of which the operators would reach the valves controlling vapor and steam lines. Whenever possible at this company's plants, the ladders have been replaced by such hazard reducing equipment as that shown in the illustration.

Effects of Fractionation on the Chemical Treatment of Gasoline

Manufacturing and refining gasoline so that it will meet all the requirements of the motoring public is often a difficult and expensive process, especially when the gasoline is made wholly or in part from cracked or pressure still distillates. The advantages of an effective continuous fractionation system in stabilizing the distillation range of the gasoline produced are generally realized, but little attention has been paid to the possibility of using this distillation equipment to reduce the amount of treating necessary and thus lower treating costs.

There are several reasons for subjecting gasoline to treatment before it is sold as motor fuel, the chief ones being to improve the color, to remove corrosive or evil-smelling sulphur compounds, and to remove the gum-forming constituent. The fundamental principle of an investigation being conducted by the United States Bureau of Mines is that these various impurities are not distributed evenly through the boiling range of all gasoline, and in some cases at least they seem to predominate in certain fractions. By careful fractionation, for example, in a bubble tower, it is possible, with some gasoline to concentrate each impurity in a small portion of the product so that these small portions are all that require chemical treatment, the greater part of the gasoline being ready to market as it leaves the condenser. A bubble tower can be used to advantage to fractionate gasoline into several portions, as streams can be drawn from different plates in addition to the product from the top of the tower. By careful study of the streams a control system can be applied to the tower, so that the greater part of the product can be obtained in marketable condition, no further distillation or chemical treatment being necessary. Some of the streams may require one type of treatment, others another type, depending on the kind of impurities each contains. This method of handling petroleum products is of value to the petroleum refiners, as it lowers the cost of refining and reduces some of the losses which always accompany chemical treatment.

In order for a refiner to take advantage of the results of good fractionation it is necessary for him to make a study of the charging stock he is using. For example, high sulphur crudes from some of the new fields in the United States are giving the refiners new problems. It is believed that good fractionation of these crudes will help in solving these problems.

Cleaning Plant Makes Obnoxious Gas Useable

Gulf Production Company installs Koppers process plant which removes hydrogen sulphide from West Texas gas with soda solution

By JACK LOGAN
Staff Representative

WITH the opening of the Big Lake field, Reagan County, and subsequently the fields in Crane, Upton, Winkler and other counties of West Texas, producers and pipe line companies were faced with the problem of handling gas containing from 10 to 13 per cent. hydrogen sulphide.

Obviously this gas is very poisonous and presents hazards throughout the fields which at any time may result in death, to say nothing of causing much loss through corrosion of equipment in the wells and of field equipment above the ground.

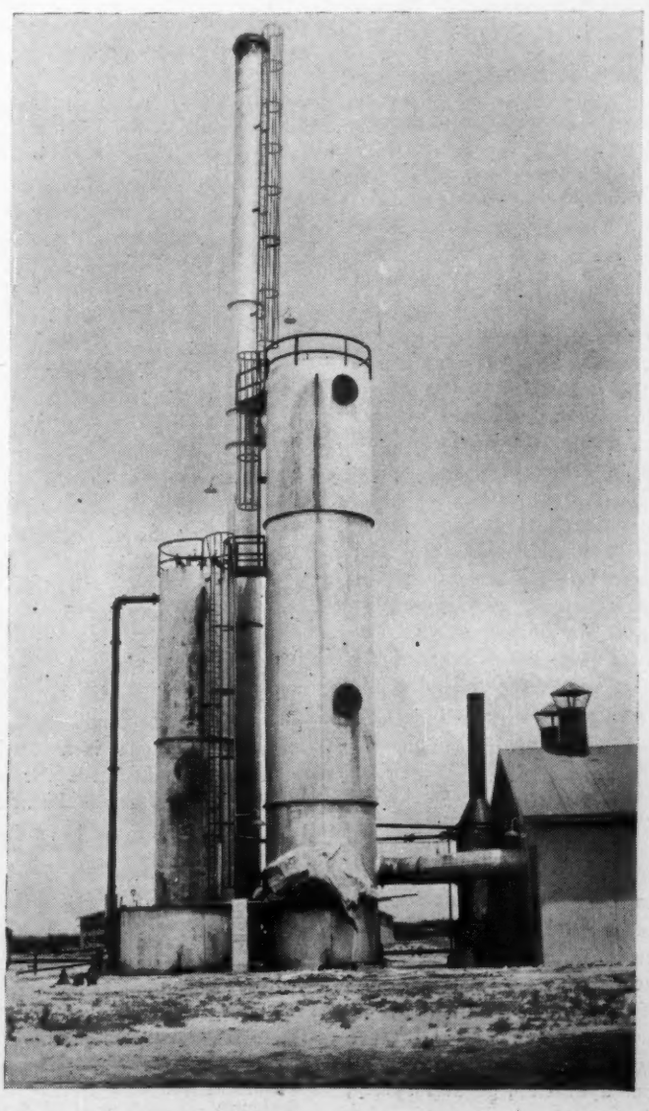
It is also very undesirable as fuel gas, and drilling, pumping, compressor and other sources of power using this gas give undue trouble. In fact, it is not economical to employ it for any use around the fields under existing conditions as long as it contains the hydrogen sulphide.

It would be possible, it is true, to use the gas for firing steam boilers, but its use for that purpose is precluded by the fact that the producers of the district are further faced with the problem of bad water. It is next to impossible to produce steam from the waters encountered there, and so the usual source of power is gasoline, gas or electricity.

Because of these bad conditions, and in view of the extensive operations in the Church-Fields-McElroy pool, both actual and proposed, the Gulf Production Company decided to obtain some process by which the sulphide gas could be removed from the natural gas, so as to provide "sweet" gas for gas engines and for domestic consumption on the property.

After studying various methods for sulphide removal, it was decided to use the Koppers process—a process designed by the Koppers Company at Pittsburgh, Pennsylvania, in handling by-products in the manufacture of coke. It may be noted here that the plant which Gulf has constructed for the utilization of the Koppers process is the first one, in so far as information is available, to be used in an oil field anywhere.

The Koppers process is unique in that the soda ash solution which is used is regenerated after becoming partially saturated.



Gas Purifying Plant of Gulf Production Company on McElroy lease, Crane County, West Texas.

Cleaning Plant

The plant, as constructed, will handle up to 750,000 cubic feet of natural gas per day. The process is essentially as follows, and may be readily understood by referring to the accompany-illustration:

The plant is made up of two steel towers, about eight or nine feet in diameter, one being 40 feet high and the other 60 feet; while a pipe, resembling a smoke-stack, is connected with the 60-foot tower, and extends to a total height of 100 feet.

Gas from the field enters the bottom of the 40-foot steel tower and passes upward, where it comes in intimate contact with a three per cent. solution of soda ash, the latter being introduced into the tower at the top through the pipe shown at the left in the picture. Going downward in the tower, the solution passes over baffle plates which allow it to come in contact thoroughly with the upward passing gas.

After making a single pass through the tower, 99 per cent. or more of the hydrogen sulphide is removed, and the purified gas is led off from the top of the tower. The spent washing solution is then pumped into the top of the 60-foot steel tower, and from there passes downward over baffle plates, meanwhile coming in contact with fresh air which is furnished through blowers. The fresh air enters the 60-foot tower near its bottom, through the pipe leading from the building to the tower. In its passage through this 60-foot tower the solution is regenerated; that is, it is made suitable for use again, and is pumped again to the top of the 40-foot tower.

The air which has passed up through the 60-foot tower, being made foul by taking up the hydrogen sulphide from the

soda ash solution, then passes from the top of that tower into the 100-foot pipe through a connecting outlet, and is expelled into the air at an altitude where it can not do any damage.

The cost of the soda ash amounts to about two and one-half cents for treating 1000 cubic feet of gas, and outside of that cost, the only expense is depreciation on the plant and the time which is required for its care. The latter item, however, is very small, as the entire operation is practically automatic, requiring very little attention other than adding some make-up solution every day. As it actually works out, one man operates the plant, using only a small part of his time for that particular work and performing various other duties.

The cost of the plant was about $50,000; and of course the larger the plant, the lower the cost of treating each thousand feet would be. And the operating cost, in so far as labor is concerned, would increase very little with increased capacity of the plant.

This gas treating plant of the Gulf Production Company is located on its McElroy lease, at a point about the center of Section 198, Crane County. It is also very near the center of Gulf's leases in the field. The Gulf holdings there comprise about 15 sections in a single block, most of which is proven for production. It was this circumstance, the extensive proven acreage, which justified the installation of the plant for treating the gas. Other companies, holding smaller leases, and those whose leases are more or less scattered, are not so favorably situated for the installation of plants so expensive.

With the gas which it treats daily in this Koppers plant, the Gulf Production Company operates about a dozen pumping wells, supplies a compressor station which the company uses for air lift in the field, and takes care of the domestic requirements throughout its camps. In addition, the company is shipping in 20 more gas engines to be used for pumping. When they are installed, the gas purifying plant will be drawn upon to the extent of its capacity.

Besides the scientific plant which Gulf is using, there are numerous small home-made installations scattered over the West Texas fields for the purpose of taking the sulphur out of the gas, all of them using caustic soda solution for absorbing the hydrogen sulphide; but in spite of these various treaters, only a very small part of the gas of the field is utilized. Even the Gulf plant described above is capable of handling the gas from only about one well.

The remainder of the gas of the fields is burned. All the gas which is not utilized by removing the hydrogen sulphide is led, after passing the separators, to points removed some distance from the wells, and is there ignited through old-time flares. In the Church-Fields-McElroy pool, several hundred of these flares can be seen burning day and night, the chief purpose of burning the gas being to dispose of the hydrogen sulphide in order to prevent poisoning and the corrosion of machinery and equipment in the field.

Cracked Gasoline by Blumner Process

Blumner'sprocess for the preparation of motor fuels synthetically has been attracting some attention during the past few fonths. A model plant is operating in Germany. Walter Roth in his news letter from Germany to the News Edition (July 10th) of Industrial and Engineering Chemistry, gives an interesting paragraph descriptive of this new cracking process. The following is excerpted from Mr. Roth's letter—

"This process of Blumner's consists in the main of pumping benzine-free crude oil or benzine-free tar under high pressure into an autoclave filled with molten lead. Through a special contrivance containing distributors—for example, Raschig rings—which is sunk into the fluid lead, the crude oil bubbles by its own buoyancy to the surface of the melt without touching the fire wall. The process is conducted under some 35-40 atmospheres at 450°, the splitting temperature of the oil. Thus there sets in a rapid circulation of the melt, which effects a constantly uniform heat transfer from the source of heat to the oil. With this cracking process of Blumner's it is said that no superheating and no real choke formation takes place. Hence the operation can go on continuously without being interrupted every few days for cleaning. All types of oil can be cracked by this process—for example, lignite tar, which is very prone to coke formation, and its distillates and even shale oil. The crude oils yield up to approximately 80 per cent. of the crude benzine, depending upon their nature. The best yields are given by the parrafin oils and distillates, such as Galician gas oil. Oils poorer in paraffin, such as most of the high asphalt-petroleums, as well as lignite tar and oil, gives poorer yields. The Blumner benzine thus obtained contains about 15-20 per cent of aromatic substances, on the presence o fwhich, as known, depends freedom from knock. About 10 per cent. of uncondensable gas is evolved by the cracking; it is used for heating and has an average heating value of approximately 12,000-14,000 calories. The Blumner process is being employed by the Blumner-Crack-Anlagen A. G. at Berlin. A model plant of about four to five tons of crude oil has been erected at Berlin-Hohenschonhousen by the firm of Borsig, G. m. b. H., of Berlin. In the Chemiker-Zeitung, Doctor Karsten-Salmony has given a detailed description of the Blumner process, together with calculations of its profitable use. As advantages over other processes, he commends the greater yields and higher quality of benzine, cheaper operation, greater safety, and more general applicablity."

Characteristics of Oil From Little Seminole

Washington—A typical analysis of petroleum produced in the Little Seminole field, Muskogee County, Oklahoma, has been made public by the United States Bureau of Mines, Department of Commerce, which is studying the characteristics of crude oils from the different fields of the United States and other countries.

The Little Seminole oil field is located about four miles southeast of Muskogee, Oklahoma. Its discovery was almost accidental, as the oil is coming from a sand that has been believed dry for the past 25 years. The discovery well, drilled to test the Timber Ridge sand ordinarily occurring about 900 feet, was plugged back and when finally shot at 525 feet on December 13, 1927, in the Hale sand, made 25 barrels per day. The average initial yield from wells is approximately 25 barrels per day, although one well is reported as producing 450 barrels the first day, and some other wells had initial production as high as 100 barrels per day. The total proven area is approximately five acres and the field production is, of course, small. The chief interest is the discovery of the field in territory that supposedly had been thoroughly explored years ago. The crude itself, like some other crudes from this part of Oklahoma, is a paraffin base oil. When viewed in a standard sample bottle the oil is light red in color with the greenish flourescence characteristic of crude oil.

A typical analysis is as follows:

Oklahoma Hale Sand		Muskogee County Well No. 1	
Specific gravity, 0.805		A. P. I. gravity, 44.3°	
Per cent sulphur, less than 0.1		Per cent water, nil	
Saybolt Universal viscosity at 70°F., 38 sec		Pour point—Below 5°F.	
Saybolt Universal viscosity at 100°F., 36 sec		Color — +	
	Per Cent	Sp. Gr.	°A.P.I. Visc.
Light gasoline	12.5	0.684	75.4
Total gasoline and naphtha	38.5	0.735	61.0
Kerosene	18.7	0.812	42.8
Gas oil	8.8	0.837-0.848	37.6-35.4
Nonviscous lubricating distillate	10.2	0.848-0.867	35.4-31.7 50-100
Medium lubricating distillate	7.1	0.867-0.879	31.7-29.5 100-200
Viscous lubricating distillate	0.0	.....	..... Above 200
Distillation loss	0.5	.....	.....
Residuum	16.2	0.907	24.5
Distillation loss	0.5	.....	.....

Composition of Petroleum and Its Products

By GEORGE A. BURRELL

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THE absolute indentification of the hydrocarbons present in petroleum practically stops when we pass the hexane fraction, and there is difficulty even in identifying the hydrocarbons of the different series in this and lower fractions and in isolating the various isomers. Work was recently done by Brown and Carr[2] on gasoline from Cabin Creek, W. Va. crude oil. Fractionation was carried to the nonane fraction. Scores of fractions were made to produce distillation curves with a semblance of flatness at the normal boiling points of the paraffins. Pure compounds were not obtained. Not only are the various isomers in the way and the boiling points too close together, but one encounters compounds of other hydrocarbon series. This and much other similar work shows the tedious nature of the problem, even in attempting to isolate the hydrocarbons of the light distillates of petroleum. These authors used a semo-laboratory rectification column and started with 135 gallons of oil. The Peters[3] column is also well adapted for close fractionation work.

When one passes the gasoline fraction, and only part of it at that, uncertainty exists as to the nature of the hydrocarbons present. We talk about paraffins, aromatics, olefins and naphthenes (including polynaphthenes) and because of the difficulty in separating individual hydrocarbons, have devised means of very roughly determining these various groups in gasoline.

Composition of Straight-Run Gasoline and Kerosene

About the best we can say as to the composition of straight-run gasoline is that eastern gasolines are predominatingly paraffinic, Mid-Continent ones not so much so, and the asphaltic oils of the Gulf Coast and California apparently produce gasolines with larger amounts of so-called naphthenic hydrocarbons, and dissolve in sulfuric acid to a greater extent, than the first two mentioned. Further, some California gasolines are decidedly aromatic, although probably all gasolines contain aromatic hydrocarbons, but possibly only in small quantity in many cases —say, in eastern gasolines.

The question of anti-knock gasolines has brought the chemical composition of gasolines sharply into relief. Paraffinic gasolines suffer in this respect and aromatic ones appear at an advantage. Highly cracked gasolines (especially vapor phase products) are particularly good anti-knock fuels. Work by Edgar[4] on a synthetic branched chain octane prepared by him disclosed the highly interesting fact that it does not produce knocking in an engine.

Kerosenes probably follow the same general trend as gasolines; the eastern ones are the most paraffinic and the California ones the most aromatic. However, it is interesting to note that Wagner[5] found no indications of paraffins in a Mid-Continent kerosene, but apparently only simple naphthenes and partly hydrogenated substituted naphthalenes.

Composition of Natural Gas

Natural gas always accompanies oil and represents the lightest hydrocarbons that were formed by the changes that produced the oil. It is composed of the paraffin hydrocarbons and usually only small quantities of carbon dioxide and nitrogen, although there are wells that produce almost pure carbon dioxide or almost pure nitrogen. In rare cases methane may be the only hydrocarbon present, making up 98 to 99 per cent. of the total. Helium is believed to be present in all natural gases, but usually in traces. Probably the largest amount recorded is 2.5 per cent. The Petrolia, Texas, gas, from which the United States Government extracts helium, contains 0.90 per cent. of helium. Hydrogen, carbon monoxide, oxygen, acetylene and olefin gases are not present in natural gas. The writer pretty well established the foregoing in his work on natural gases for the U. S. Bureau of Mines.

The fact that there are no gaseous olefins in natural gas practically precludes the presence of the liquid mono-olefines in petroleum, because if members of the liquid mono-olefins were present in oil—say, amylene, hexylene, etc., one would expect to find ethylene, propylene and butylene in the gas. Fortunately tests for the olefin gases are quite well defined and easy to conduct, so that there is not much chance of missing them in the natural gas if they are present. The same is true of acetylene and the other gases mentioned.

With the gaseous members of the naphthene series—cyclopropane, for example, the case is different. The writer knows of no qualitative test that would detect it, say, in a mixture of paraffins. It is about as soluble as sulfuric acid is propylene; hence it is much more so than propane, but propane and higher paraffins are so soluble that it would be difficult to separate out the cyclo-propane with sulfuric acid, especially if only a small amount were present. Further, it could easily be lost in the calculations when determining the paraffins by combustion. It could not be readily separated by fractional distillation at low temperatures from the propane, for propane boils at —45 degrees C. and cyclo-propane at —35 degrees C. Cyclopropane has been identified in petroleum, and possibly the only reason cyclo-butane and cyclo-propane have not is that not enough work has been done. The latter is the lowest member of the series. However, we are pretty safe in saying that a petroleum must be highly naphthenic for cyclo-propane to be present in quantity in the gas accompanying the oil. On the other hand, Howard[6] mentions a gasoline containing 70 per cent. of naphthenes.

Vapors of benzene particularly are doubtless present in natural gas from wells containing aromatic oils; the proportion would depend upon the temperature of the gas and the amount of aromatics present in the oil. Gases from such oil wells as those of Borneo, where the gasoline fraction may contain 40 per cent of aromatics, would contain a small quantity of the aromatic vapors, principally benzene. Pure benzene has a vapor pressure of 760 mm. at 81 degrees C.

However, despite the probable presence of small quantities of cyclo-propane and benzene in some natural gases, in most cases the paraffins are the only hydrocarbons present.

The absence of the unsaturated gases and carbon monoxide and hydrogen from natural gas has a bearing on the formation of petroleum. These gases are products of destructive distillation. Their absence from natural gas indicates that whatever changes (anaerobic fermentation, according to some)

[1]Received February 13, 1928. Excerpts from "The Technology of Petroleum Refining," to be published by The Chemical Catalogue Co., A. C.S. Monograph Series.
[2]Ind. Eng. Chem., 18, 718 (1926).
[3]Ibid, 18, 69 (1926).
[4]Ind. Eng. Chem. 19, 145 (1927).
[5]Ind. Eng. Chem. 16, 135 (1924).
[6]Ind. Eng. Chem. 18, 936 (1926).

took place to produce petroleum were low temperature changes. It is possible that the olefins have polymerized partly to higher hydrocarbons and that hydrogenation occurred, but this seems unlikely. Bergius finds that tremendous pressures and high temperatures are necessary to make hydrogen unite with coal. Catalysts speed up the hydrogenation, but this postulates the presence of specific catalysts, such as nickel (Sabatier), or some similar to those used by Fisher and Tropsch in their work.

Olefins and Other Unsaturated Hydrocarbons in Petroleum

Olefins or other unsaturated hydrocarbons have never been identified in crude petroleum, except Mabery's work which showed traces of hexylene, heptylene, octylene and monylene in Canadian petroleum[7] although we wonder why some petroleums are so reactive with sulfuric acid. The only explanation we have is that the higher paraffins, aromatics, and so-called polynaphthenes are themselves exceedingly reactive or, particularly, that members of the unsaturated cyclic hydrocarbons are present in western oils in large amounts, although they have never been identified therein. It is also probable that hydrocarbons having a benzene nucleus are present in the higher boiling fractions of petroleum. The aromatic hydrocarbons are not classed as unsaturated compounds in petroleum technology, although the Kekule ring contains double bonds.

Paraffins

The wax fractions have been investigated quite thoroughly, with the conclusion that they are paraffinic. Several investigators have shown that the difference between so-called amorphous and crystalline wax is simply one of crystal formation.

The latest work is that of Buchler and Graves.[8] They found paraffin hydrocarbons ranging from $C_{18}H_{38}$ to $C_{43}H_{88}$ in paraffin, slop wax, petrolatum and rod wax. Of interest was their discovery of an unknown substance called soft wax. It causes the formation of needle crystals in impure waxes and vaseline when high melting-point waxes and vaseline are mixed with oil. Of decided interest in connection with their work is the fact that in Pennsylvania refining practice a wax distillate fraction can be pressed direct from a tube still and rectifying column. No drastic cracking of the distillate occurs. Apparently better fractionation and temperature control makes possible the rejection of the high-boiling soft wax isolated by Buchler and Graves, and which inhibits good crystal formation.

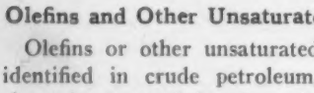
No paraffins have been identified in the lubricating fractions other than wax, probably because of the difficulty of freezing out and identifying these of lower boiling points. They apparently become lost in the experimental work performed in isolating the polynaphthenes, for usually only those hydrocarbons of C_nH_{2n-x} characteristics have been reported in lubricating oils.

However, it is well that the paraffins are not present in appreciable quantity in lubricating oil, for they lack viscosity. Any lubricating value that so-called paraffin-base oils possess is not due to the paraffin hydrocarbons.

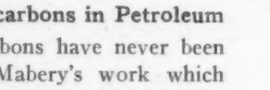
Naphthenes, Polynaphthenes and Lubricant Fractions

The data at hand indicate that the great bulk of the heavy fractions of our crude pertoleums are made up of the so-called polynaphthene hydrocarbons, C_nH_{2n-x}. These are generally called saturated cyclic hydrocarbons, although some investigators, and probably correctly, call the higher members unsaturated hydrocarbons. Naphthene hydrocarbons, C_nH_{2n}, were named so by Markovnikov, a Russian chemist, who discovered them in Baku petroleum forty years ago. The simple naphthenes, C_nH_{2n}, appear in the light fractions. Cyclo-pentane is the lightest one so far identified. Markovnikov[9] isolated cyclo-hexane from Baku petroleum and Young later found it in American petroleum. Cyclo-hexane is probably fairly common in light distillates of the mixed-base and asphaltic-base types. More work has been done on this naphthene hydrocarbon than on any of the others.

For most of our information on the polynaphthenes (C_nH_{2n-2} to C_nH_{2n-20}) we are indebted to Mabery; others include Coates, Wilson, Allibone and Thole. Carbon and hydrogen ratios were determined, and these fit the formulas for the poly-naphthenes. The naphthenes are commonly written:



Cyclo-pentane



Cyclo-hexane

The simple naphthenes are isomeric with the olefins, but there the identity ends. They are more resistive to heat and chemicals than the olefins. Like the olefins, they possess valuable anti-knock properties. The polynaphthenes possess good lubricating value; the paraffins do not. Whether higher unsaturated molecules of cyclic structure are also present and do or do not possess lubricating value, we do not know. Some technologists believe that, whatever their structure, they do make valuable lubricants. But there is little substantiation of this matter, except possibly that highly refining a lubricating fraction with sulfuric acid, like certain medicinal oils, makes of these oils a poorer lubricant than the unrefined oil. Probably for so-called boundary lubrication these unsaturated molecules possess some advantage, but all commercial lubrication is of the fluid kind.

Mabery did not find the simple naphthenes, C_nH_{2n}, in any of the lubricating fractions that he examined. The inference from his work is that, although they occur in the light distillates, they are not present in the lubricating fractions. However, Seyer and Huggins [10] found simple naphthenes in a lubricating fraction from Peruvian petroleum, also polynaphthenes. Seyer[11] found that a fraction of a lubricating oil which he separated by means of liquid sulfur dioxide withstood a friction test better than the fraction not dissolved in sulfuric acid and which he called the saturated portion. He found the latter portion to be more stable oxidation.

Wilson and Allibone[12] call the polynaphthenes higher than C_nH_{2n-8} unsaturated molecules, and those of lower weight saturated ones. As far as we know, the lower ones (less than C_nH_{2n-12}) constitute most of the lubricating oils of commerce.

Mabery [13] concluded that residual lubricants of Pennsylvania crude oil contained percentages of carbon and hydrogen corresponding to the hydrocarbon series C_nH_{2n-8} and to the series C_nH_{2n-10} and C_nH_{2n-12} for the heavier Ohio, Mid-Continent and Texas oils. Apparently the difference in lubricating values of various petroleums lies in the proportions of these polynaphthene hydrocarbons present. But this would be an exceedingly unsafe generalization to make without more knowledge of the components of lubricating oils. As we go too high in the series, up to C_nH_{2n-20} the fractions lose viscosity and become sticky. Mabery [13] states that with the C_nH_{2n-20} series one approaches the asphaltic hydrocarbons. The overhead lubricating oils apparently contain various portions of the series C_nH_{2n-2} to C_nH_{2n-8}. This line of demarcation is only approximate, of course.

It has been noted that the eastern lubricating oils are more resistant to oxidation, have higher flash and fire-points and produce less carbon than western oils, although carbon from an eastern lubricant sticks more tightly to the piston head of an automotive engine. This is because a greater proportion distills away from western oils as they are more volatile.

The conclusion is inevitable that some of the hydrocarbons are of a different type in the two oils, or that there is more of one type in one oil than in the other. The indications are that there are more unsaturated groups in the western oils. This might follow from the greater reactivity of these oils

[7] Proc. Am. Acad. Arts. Sci., June, 1905, p. 110.
[8] Ind. Eng. Chem. 19, 718 (1927).
[9] Ber. 30, 974, (1897).
[10] Trans. Roy. Soc. Can., 20, 193 (1926).
[11] Ibid., 15, Sect. III, 69 (1921).
[12] J. Inst. Petroleum Tech., 11, 177 (1925).
[13] Ind. Eng. Chem., 19, 526 (1927)

toward sulfuric acid. Dunstan and Thole[14] are of the opinion that it is the unsaturated molecules of a lubricant that enter into firm physical-chemical union with the metallic surfaces, forming a friction surface which is a compound of oil and water. But this is only of importance in so-called boundary lubication, whereas all practical lubrication is of the fluid type and here viscosity is of importance. Smith[15] finds indications that certain of the hydrocarbons in a Wyoming oil are of the same type as those in an Appalachian oil and that others may be classed as unsaturated hydrocarbons.

Stager[16] extracted a part of a turbine oil (sludge-forming constituents) with methanol and stated that the extracted portion consisted of unsaturated hydrocarbons, although the oil still sludged after their removal.

No attempt is being made here to compare the relative merits of different classes of lubricating oils. For one thing, the writer has not enough data at hand with which to make such a comparison. It seems to be the general opinion that good lubricants can be made from most crude oils, but at more expense from western ones. Of course western crude oil costs less. It is significant, however, that the General Motors Company[17] pay much more attention to viscosity and volatility in rating a lubricating oil than used to be the case.

Improved automobiles and improved roads have led to the manufacture of high-speed cars, and engines run hot at high speed. Hence, in some cars at least, an oil is needed that does not volatilize too fast. High ventilation of crankcases aids this evaporation. On this basis eastern lubricants have an advantage. The biggest problem in lubricant manufacture at present is to produce a "thin-thick" oil, one that is sufficiently mobile when starting up a more or less cold automobile and is viscous enough at high temperatures when the machine attains speed.

No unsaturated cyclic hydrocarbons have been identified in petroleum, but there is strong reason to suspect their presence, especially in the heavier fractions of mixed-base and asphaltic-base oils. These fractions are very reactive to sulfuric acid.

Members of the unsaturated monocyclic and polycyclic series, C_nH_{2n-6} to C_nH_{2n-30}, of benzine nucleus, have been suspected of being present in crude petroleum. These series include the naphthalenes, diphenyls, anthracenes, picenes, etc. They are all acted upon more or less by sulfuric acid. Naphthalene has been identified in distillation products.

Acetylene, Diolefins and Terpenes

Members of the acetylene series and the terpenes have never been identified in crude petrolum or its fractions. Terpenes are a special group of hydrocarbons of the general formula $C_{10}H_{16}$, well-known members of which are pinene and limonene. Some members of the diolefins are allene; butadiene—1, 2; butadiene—1, 3; and pentadiene—1, 4. Armstrong and Miller[17a] found butadiene in oil gas, as did Engler and Staudinger, but only in the case of recent work by Brame and Hunter[18] have they been indicated in cracked gasoline. The diolefins are isomeric with acetylenes.

Terpenes and diolefins are said to occur (but not confirmed) in cracked petroleum; and the diolefins particularly are said to be responsible, at least in part, for gum formation in gasoline, and probably account for the bright yellow color of freshly distilled highly cracked gasoline, such as vapor-phase gasoline.

Gurwitsch[19] mentions a crude petroleum found in Java which he states is very rich in unsaturated hydrocarbons, but the nature of which has not been determined. The oil has the odor of terpenes and dries when exposed in thin layers.

The writer has noticed the turpentine-like odor possessed by light distillate condensed from natural gas in a Louisiana field. Brooks[20] states that gasoline from petroleum obtained from the Jennings field in Louisiana and the Mirando field in Texas, has the same odor. Coates and Tims[21] have shown, however, that the Louisiana gasoline is naphthenic and has none of the characteristic properties of turpentine.

Thole found hydrocarbons of camphoraceous odor and marked chemical stability in crude oil from Badarpur, India. Hydrocarbons up to $C_{14}H_{28}$ were isolated.

Aromatics

Aromatic hydrocarbons have been isolated in the light distillates of petroleum. In some of them they constitute a large portion of the motor-fuel fraction. Borneo gasoline may contain 40 per cent. of aromatic hydrocarbons. Some California gasoline is decidedly aromatic. It is possible that all crude oils contain aromatic hydrocarbons, because Erskine[22] found traces even in Pennsylvania casing-head gasoline, but no work has been done positively to identify aromatic hydrocarbons or their derivatives in the heavier fractions except by Carpenter[23] who obtained indications of aromatic hydrocarbons up to pentaethyl benzene, b.p. 277 degrees C., in Burmah crude oil. Brooks[24] noted that all petroleums that had been studied had been shown to contain benzene and its simpler homologs.

Aromatic hydrocarbons interfere with the burning properties of California and other kerosenes, and liquid sulfur dioxide adequately removes them. Pennsylvania lubricants are not acid treated (only filtered), but western lubricants are given an acid treatment, sometimes a heavy one so that some of the original compounds are removed and do not appear in the lubricants. As far as we know, the compounds removed are the more easily reactive saturated polynaphthenes and possibly unsaturated cyclic compounds and, of course, sulfur and nitrogen compounds and naphthenic acids. Certain substances, not pure hydrocarbons, cause lubricating oils to darken on exposure to air, but we do not know what these compounds are.

Color in Petroleums

We do not know what causes color in petroleums. Brooks[25] suggested that the volatile coloring matter in freshly distilled highly cracked gasoline may be due to diolfins, in that the fulvenes are shades of yellow, orange and red. Fulvene itself

$$\begin{matrix} CH = CH \\ CH = CH \end{matrix} \!\!> C{=}C < \begin{matrix} R \\ R \end{matrix}$$

is a yellow oil. Brooks[26] also stated that the discoloration in petroleum distillates was due primarily to the oxidation of sulfur compounds, as of mercaptans to sulfonic acids and sulfuric acid. Also, any trace of sulfur dioxide left in the oil, or introduced by decomposition when rerunning acid treated products, oxidizes to sulfuric acid, with resulting discoloration. Brooks[27] also believes that fluoresence of petroleum distillates is due to traces of substances of the nature of chrysene, fluorene, or pyrene. Tauz[28] believes the chief cause of coloring matter in gasoline to be unsaturated hydrocarbons of a cyclic character.

Carpenter[23] has also stated that color reversion is due to unstable resin-forming bodies and some of these are members of the five ring cyclo-pentadiene family, including indene, coumerene, fulvenes, fluorene and their homologs and condesation products, and that there is a marked tendency toward the formation of peroxides of members of these classes. This confirms the earlier observations of Brooks that cyclo-pentadiene, indene, fulvenes, etc., are notorious for rapid auto-oxidation; that the resinous oxidation products, formed via peroxides, are pale yellow if pure; and that in the presence of a trace of

[14] Chem. Met. Eng. 28, 300 (1923).
[15] Bur. Mines, Repts. Investigations 2837 (1927).
[16] Helv. Chim. Acta, 6, 893 (1923).
[17] Oil Gas J., 25 (Nov. 10, 1927).
[17a] J. Chem. Soc. (London) 49, 80 (1886).
[18] J. Inst. Petroleum Tech. 13, 794 (1927).
[19] "The Scientific Basis of Petroleum Technology", p. 21 (1924).
[20] "The Non-Benzenoid Hydrocarbons," p. 590 (1922).
[21] J. Soc. Chem. Ind., 20, 690 (1901).
[22] Ind. Eng. Chem., 18, 694 (1926).
[23] J. Inst. Petroleum Tech., 12, 518 (1926).
[24] J. Am. Chem. Soc., 38, 393 (1916).
[25] Personal communication.
[26] Ind. Eng. Chem., 18, 1108 (1926).
[27] "The Non-Benzenoid Hydrocarbons," p. 549 (1922).
[28] Z. angew. Chem., 39, 685 (1926).

mercaptan or alkyl disulfide, invariably present, the oxidation is accompanied by strong discoloration.

Gums

Smith and Cook[20] found aldehydes, including formaldehyde, in gasolines containing gum. Gums which they isolated become hard and brittle, partaking of the nature of the synthetic resin, Bakelite. Brooks pointed out that phenols are not present; peroxides are first formed and the "gum" is initially a fluid mixture, a part of which is resinous.

Brown[20] found gum deposited from manufactured carbureted water gas (high temperature cracking of oil) to consist of oxidation products and polymers of styrene and indene.

It is commonly stated that the diolefins are largely responsible for gum formation, by polymerization, but this, while probably true, is only conjecture. They are known to be bad gum formers.

Cracked Products

A tremenodus amount of the petroleum of the country is destructively distilled to produce compounds different than those occurring in the original oil, but our knowledge of these products is far from complete. A heterogeneous mass of data has been collected showing the qualitative character of the hydrocarbons present under different conditions of temperature, time, catalyst and pressure, when different oils are cracked or when some of the simpler hydrocarbons are cracked. A great amount of work has been done on investigations of this kind. We know that mild cracking (750-950 degrees F. or 399-510 degrees C.) produces the maximum amount of motor fuel. Higher temperature (about 1100 degrees F. or 593 degrees C.) cracking produces less motor fuel and more gas, and a motor fuel more aromatic in character. At still higher temperatures (1350-1750 degrees F. or 732-954 degrees C.) one gets into the gas-making range. The gases can be very precisely anlayzed by fractional distillation at low temperatures although, aside from the writer's work and more recent work at the Bureau of Mines laboratories, the method is employed but little. The simpler liquid hydrocarbons in the cracked products can be identified by fractional distillation, but beyond the hexane-hexylene-cyclohexane fraction the operation becomes difficult.

We know that new paraffins, aromatics, naphthenes and olefins are formed, and substances like the diolefins. The more drastic the heating the more unsaturated the product becomes and the more gas and coke are formed. Polymerization changes occur simultaneously with decomposition changes. There have been scores of investigations showing something about the nature of the lighter products formed. Paraffins, olefins, naphthenes and aromatic hydrocarbons have all been cracked. As regards these decomposition and polymerization changes, the following generalizations have been made:

1—Low temperature (gasoline-making) splitting of the paraffin molecule results in the production of molecules of the paraffins and olefins of nearly equal size. High temperature Splitting (gas-making) makes a large olefin and a small paraffin.

2—The aromatics are more resistive to heat than the paraffins. The C-C bond is more difficult to break than the C-H bond. The aromatics retain their carbon structure on decomposition to a marked degree.

The conversion of petroleum into aromatic hydrocarbons has followed an interesting course. Forty or fifty years ago commercial cracking (principally at atmospheric pressure) was carried on to make kerosene, on the one hand, and aromatics, on the other. In making kerosene a large amount of gasoline was made but there was little demand for the latter. During the late war high temperature cracking was employed, but without much success, to make benzene and toluene for explosives. Now it is employed again in some degree to make an aromatic and olefinic anti-knock gasoline.

3—Acetylene, if formed during the transition, polymerizes to other products; at least it has not been identified in the products. Possibly the cracked products have not been carefully examined for traces of acetylene.

4—Size for size of the molecule, the paraffins decompose more easily and produce less carbon than either the naphthene or aromatic molecules. Of course, the heavier molecules of all series crack most easily. The unsaturated molecules, the olefins and probably certain unsaturated cyclic ones which may be present in petroleum, no doubt crack more readily than the parafins, saturated cyclic ones, or the aromatics. The olefins and other unsaturated compounds are more susceptible to polymerization, either by means of acid or heat, than the others mentioned. They probably under-go a whirl-wind of decomposition and polymerization changes during the cracking process.

5—Equilibrium conditions are not set in commercial cracking reactions. The composition of the material is changing up to the time the temperature falls below the cracking temperature. The system $CH_4 \rightleftarrows 2H_2 + C$ comes to equilibrium, and Cantelo[21] found that, whether the initial system is methane, ethane or ethylene, the final equilibrium system will be methane, carbon and hydrogen. This indicates that all the petroleum hydrocarbons must first be reduced to methane before an equilibrium reaction is set up.

6—Pressure per se is said to have no effect on cracking reactions. However, it has a profound indirect temperature effect. Apparently polymerization is not independent of pressure. High pressure cracked gasoline is more saturated than low pressure gasoline, but not enough work has been done to differentiate between temperature and pressure effects. Even to the splitting of the molecule, the rate of reaction may be effected, but there is on experimental evidence of this matter.

7—Cracking varies directly with the temperature. It has been stated that in the cracking range, around 800 degrees F. (426 degrees C.), the rate doubles for each 18 degrees F. (10 degrees C.) rise in temperature. The rate at vapor phase and gas making temperatures is much lower. Given time enough, the molecule splits at comparatively low temperatures, say 600 degrees F. (316 degrees C.) or less, but becomes appreciable at around 700 degrees F. (371 degrees C.) in a relatively short time. Commercial cracking temperatures are going higher all the time, as high as 950 degrees F. (510 degrees C.) in so-called liquid phase systems. Polymerization of amylene may occur at 140 degrees F. (60 degrees C.) (Lebedev) and with fullers earth at ordinary temperatures (Gurwitsch). Polymerization occurs in a bubble tower of a cracking unit. The Standard Oil Company of Indiana, in defending the Lewis and Cook patent (U. S. Government vs. Patent Club) covering the use of a bubble tower on a cracking still, stress its action in aiding polymerization. The factor is simple, a time and temperature factor. Polymerization will occur to some extent in any tower, if the temperature is high enough and sufficient time is allowed.

8—Size for size of the molecule, the paraffins produce the least coke upon cracking and the aromatics the most. (This refers to hydrocarbons of which we have information). Polynaphthene hydrocarbons are apparently intermediate.

9—Diolefins are said to be produced in cracking reactions, and they probably are, but they have not been identified in the cracked products, except in oil gas and possibly in one case in cracked gasoline. The higher cracking temperatures evidently favor their formation.

10—No satisfactorly evidence has been put forward to show that catalysts, except aluminum chloride, in various commercial cracking operations have any effect on the yields.

11—Bone[22] first put forward the theory of the formation by dehydrogenation of the unsaturated residues: CH_2 and: CH, stating that they enjoy a fugitive but really independent existence. Hurd and Spence[23] postulate their formation, as does

[20] Bur. Mines Repts. Investigations, 2394 (1922).
[20] Gas Age Record, 50, 571 (1922).
[21] J. Phys. Chem., 31, 124 (1927).
[22] "Coal and its Scientific Uses," p. 143 (1922).
[23] Bull. Am. Petroleum Inst., September 21, 1927.

Dunstan and Nellysteyn[34] followed up Bone's idea to show the mode of decompositon of ethane and ethylene by means of these residues. Nellysteyn gives acetylene an important role in the decomposition and synthesis of the hydrocarbons. Other investigators—Haber, Bone and others, have practically eliminated it. Bethelot was the first to give it a prominent part in aromatic condensation. The mode of a decomposition of the hydrocarbons and intermediate products formed is one of the most difficult subjects to unravel in the whole realm of chemistry.

12—The work of Faragher, Morrell and Comay[35] on the decomposition, at cracking temperatures, of the sulfur compounds in petroleum is very interesting. They found thiophene to be the most resistive, and stated that this probably accounts for the fact that certain oils high in sulfur are not so corrosive as some of lower sulfur content, in that thiophene-like derivatives do not break down into the corrosive hydrogen sulfide. The latter is the only one of the sulfur compounds in petroleum, or formed when petroleum or its products is cracked, which is corrosive.

13—The cracking process today is the result of a cut-and-dry process, and a highly commendable one. Millions of dollars were expended with economic pressure behind the work. Combinations of pressure, time, charging stocks and equipment were finally welded into the commercial processes of today. All the successful ones are much alike, now with expensive litigation under way to determine priority. But there is a woeful lack of knowledge of the chemical changes involved.

Some of the greatest advances in cracking processes have been (1) the speeding up of the oil through tube stills; (2) pumping back of hot, clean reflux; and (3) stopping the reaction of making too much coke. Temperature control, fractionation, selection of equipment materials, control of corrosion, etc., have also helped.

(Note)—No. 3 is the so-called flash method. By this method coke formation can be reduced to a small percentage of that formerly made.

Chemistry of Coke Formation

Petroleum coke is a mixture of high molecular weight hydrocarbons that are condensation products rich in carbon and poor in hydrogen. Brooks[36] states that it is formed via intermediate formation of complex aromatic compounds, and quotes Prunier[37], as long ago as 1879, and others, as having isolated a series of fluorescent hydrocarbons from petroleum coke. He notes that the paraffins can be cracked at moderate temperatures without forming coke, but that in the remarkably stable six-carbon ring structure the result is chemical condensation to larger and larger molecules and eventually to coke, with the liberation of hydrogen and other simple split products such as methane, ethylene, ethane, etc.

Sachanov and Tilicheer[38] have concluded that the lighter and heavier cracked products are produced by different constituents of the original oil. Paraffin wax purified with fuming sulfuric acid produced no coke or other condensation products on cracking, these substances being produced at the expense of the aromatic compounds. Herbst[39] found that no coke was produced when he cracked paraffin wax in the presence of activated charcoal.

Of course, paraffin wax or any other hydrocarbon, if heated drastically enough, will break down with the production of carbon, but apparently the aromatics are the real coke formers in a cracking system.

[34] J. Inst. Petroleum Tech., 10, 317 (1924).
[35] Ind. Eng. Chem., 20, 527 (1928).
[36] Ind. Eng. Chem., 18, 518 (1926).
[37] Ann. chim. phys., (5) 17, 28 (1879).
[38] Petroleum Z., 23, 521 (1927).
[39] Z. angew. Chem., 39, 194 (1926).
[40] Am. Inst. Chem. Eng., St. Louis, Mo., Dec. 5 to 8, 1927.
[41] Ind. Eng. Chem., 18, 518 (1926).
[42] Bull. Am. Petroleum Inst. (1927).
[43] Pyhala found that the nitrogen compounds in lubricating distillates were attacked first by sulfuric acid, Petroleum, 9, 1506 (1914).
[44] Am. J. Sci. 35, 422 (1906).
[45] J. Chem. Soc. (London) 127, 2756 (1925).
[46] Wendt and Diggs, Ind. Eng. Chem., 16, 1113 (1924); and Wood, Lowy and Faragher, Ibid., 16, 1116 (1924).

Oxidized Products

The character of the products formed when oil is oxidized at high temperatures is such that at the moment their identification in anything like a quantitative way is hopeless. Alcohols, ketones, aldehydes, naphthenic acids and other substances formed make up an exceedingly complex mixture. One commercial plant[40] (founded on work of J. H. James) is in operation at Nyack, N. Y., making "Aldehol," a commercial name for a denaturant for alcohol.

Petroleum Acids

We know little about acids found in petroleum or its products, except the so-called naphthenic acids. Presumably these are the only important ones. They are the carboxylic acids of the naphthenes, $C_nH_{2n-1}COOH$. Their isolation is made difficult by the presence of a larger number of isomers. They form salts with bases—e.g., sodium and potassium—and these salts are soluble in water and have the consistency of soft soap. In Russia an inferior soap is made from them, and in this country naphthenic acids are used in greases to some extent, after their extraction from alkaline sludge.

Nitrogen Compounds

Not much is known about the nitrogen compounds in petroleum, except that they consist of pyridine, quinoline, and their hydrogenated derivatives. Mabery and Hudson[41] isolated the six compounds $C_{13}H_{17}N$ to $C_{18}H_{21}N$. The element itself in these compounds may constitute several per cent. of some crude petroleums according to our present knowledge.

Recent work by the American Petroleum Institute[42] (Bailey and others) indicates that most of the nitrogen in "lube" stock passes into the sludge[43]. They say that their work when published will eliminate from the literature many exaggerated statements about the nitrogen content of California and certain Texas crude oils.

Oxygen

About the only information we have about oxygen in crude petroleum is that it exists in the so-called naphthenic acids and in some cases in phenols.

Sulfur

There is considerable literature on the sulfur compounds in petroleum, principally because certain investigators—Wendt, Diggs, Morrell, Faragher, Wood, Egloff and others—found in treating refractory cracked distillates a problem of economic importance and one that demanded investigation if cracked oils were to be intelligently refined. The excellent work to date on prepared sulfur compounds in oils and on treating reactions shows what can be done when trained investigators attack a difficult problem, although work on the isolation of sulfur compounds is scant.

The principal sulfur compounds are hydrogen sulfite and organic sulfides, disulfides, mercaptans, thiophenes, sulfones and sulfoxides. Mabery[44] isolated a class of compounds called thiophanes, $C_nH_{2n}S$, but could no identify their structure. There has been some confirmation of his work through the synthesis of similar compounds by others, and the isolation of similar compounds by Thierry.[45]

Sweetening Reaction

The course of the reactions in sweetening oil has been well established by the work of Wendt, Diggs, Wood, Lowy, Faragher and Morrell.

Sodium plumbite[46] reacts with mercaptans to form a yellow mercaptan, thus:

$$\begin{matrix} C_2H_5SH \\ | \\ C_2H_5SH \end{matrix} + Na\ Pbo = \begin{matrix} C_2H_5S \\ \\ C_2H_5S \end{matrix} > Pb + 2NaOH$$

The lead sulfide then forms owing to a gradual oxidation by means of sulfur dissolved in the oil.

$$\begin{matrix} C_2H_5S \\ \\ C_2H_5S \end{matrix} \!\!>\!Pb + S = \begin{matrix} C_2H_5S \\ | \\ C_2H_5S \end{matrix} + PbS$$

The diethyl sulfide is soluble in the oil and does not react with the doctor reagent. No sulfur has been removed, but the oil is sweet nevertheless. (A sweet oil implies the absence of mercaptans and hydrogen sulfide).

The sweetening can be conducted equally well if sulfur is added to the solution of the mercaptan before treatment with plumbite, thus:

$$\begin{matrix} C_2H_5SH \\ \\ C_2H_5SH \end{matrix} + S = \begin{matrix} C_2H_5S \\ \\ C_2H_5S \end{matrix} + H_2S$$

However, care must be exercised in adding sulfur else the sulfur content of the oil will be increased to the extent that the gasoline may become corrosive.

It is common knowledge that the black precipitate (lead sulfide) that forms during sweetening with sodium plumbite is itself a fairly good sweetening agent. Oxygen is necessary, as shown by Morrell and Faragher[47] for the lead sulfide to be effective.

$$PbS + 4NaOH + 2O_2 = Na_2PbO_3 + Na_2SO_4 + 2H_2O$$

The usual reaction for the formation of lead mercaptides in any system where sodium hydroxide, lead sulfide and oxygen are present, is

$$2RSH + Na\ PbO \rightarrow \begin{matrix} R{-}S \\ \\ R{-}S \end{matrix} \!\!>\!Pb + 2NaOH$$

To remove hydrogen sulfide from an oil, a simple water wash or a caustic soda wash at best is all that is necessary.

Action of Sulfuric Acid

The principal reactions when sulfuric acid acts on unsaturated compounds are: (1) the formation of alkyl-sulfuric acid esters; (2) formation of alcohols; and (3) polymerization. There is much speculation about the mechanics of polymerization by sulfuric acid.

Mercaptans[48] are oxidized to the corresponding disulfide by concentrated sulfuric acid. Alkyl sulfides are very soluble in sulfuric acid. The same is true of sulfoxides and sulfones. Oxidation changes are of minor importance. However, sulfuric acid dissolves and reacts with the organic sulfur compounds sufficiently to produce satisfactory results, especially in combination with caustic soda or sodium plumbite. The action of sulfuric acid on hydrogen sulfide is an oxidizing one.

Brooks and Humphreys[49] established that the pure mololefins up to $C_{20}H_{40}$ do not form tars with sulfuric acid at 15 degrees C., but only form esters, or tester acids, alcohols and polymerized products. The simple dienes do react very energetically with concentrated sulfuric acid to form tars. Tar formation in the refining of lubricating distillates has not been explained.

Asphalts

We are hopelessly at sea regarding the nature of the compounds present in the asphaltic portion of oil. They are usually classified by separating them into groups depending upon the solubility of different fractions in various solvents. Chemically they are sometimes called oxygen-containing and sulfur-containing compounds; unsaturated cyclic compounds; some of them Polycyclic hetero-compounds of a saturated character, the asphaltenes, resins (because some portions resemble vegetable resins in some respects), etc. All this is more or less meaningless from a chemical standpoint. The action of oxygen, halogens and other substances on them has been investigated, but has not led to their identification.

Hydrocarbon Groups

A scheme of separating the hydrocarbons in gasoline is used whereby the unsaturates are separated by sulfuric acid of moderate strength aromatics with acid of higher strength, and naphthenes by the aniline point method,[50] and the paraffin by difference. Another scheme includes the nitration of the aromatics. Egloff and Morrell[51] have examined and critically discussed the latter method. The method gives rough results when applied to motor fuel, but is hopeless for heavier fractions.

Brame,[52] Moore and Hobson,[53] Houghton and Bowman,[54] and Morrell and Egloff use for the unsaturates concentrations of acid varying from 80 to 91 per cent. What is wanted is an acid of a strength that will attack the unsaturates but not the aromatics. (Aromatics are not classed as unsaturates in the petroleum terminology.) About this there is much difference of opinion, due largely to the various types of gasolines worked with and the fact that under the most precise conditions only an approximate separation can be made, and one that can by no means be relied upon to show the actual amount of unsaturated hydrocarbons present.

Alcohol From Petroleum

Aside from a long line of gasolines, kerosenes, lubricating oils, fuel oils, greases and special oils of a hundred different kinds, the only petroleum product of consequence, and one which is of a decidedly chemical nature, a by-product in fact, is secondary isopropyl alcohol. It is made under patents of the Standard Oil Company of New Jersey[55] from propylene of cracked gases.

$$\underset{\text{Propylene}}{CH_3CH = CH_2} + H_2SO \rightarrow \underset{\text{Secondary propyl sulfuric acid}}{CH_3CH\ (HSO_4)\ CH}$$

The propyl sulfuric acid is hydrolyzed to produce the alcohol, thus:

$$CH_3CH\ (HSO_4)\ CH_3 + H_2O \rightarrow CH_3CHOHCH_3 + H_2SO_4$$

Other secondary alcohols are made, but not in quantity. In fact, the supply of isopropyl alcohol that can be made far exceeds the demand.

The reaction given above has long been known. A plant to produce the alcohols from coal gas was built in 1900. The reaction was made known by Hennell in 1828.[56] Probably the Standard Oil Company's key patent is one whereby the gas is passed through a mixture of sulfuric acid and oil at a temperature below 30 degrees C.

A. D. Little, Inc., have made tertiary alcohols[57] at a semi-

$$R{-}\underset{\displaystyle R}{\overset{\displaystyle R}{\underset{|}{\overset{|}{C}}}}{-}OH$$

commercial plant at Tiverton, R. I., working under a grant from the Standard Oil Company of New York, the Barnsdall Company, and others, but to date little commercial success has attended the venture.

Ethylene Glycol From Natural Gas

The Carbide & Carbon Chemical Company make a line of glycols, principally ethylene glycol, from ethylene, by cracking rich natural gas (tail gas from natural gasoline plants) and absorbing the ethylene in acetone under pressure. Upon re-

[47] Ind. Eng. Chem., 19, 1045 (1927)
[48] Wood, Lowy and Faragher, Ibid., 16, 1116 (1924); Wood, Sheely and Trusty, Ibid., 18, 169 (1926).
[49] J. Am. Chem. Soc., 38, 393 (1916).
[50] Erskind has used nitrobenzene with better effect, and Ford removed the aromatics with silica gel. The aniline point method was developed from the work of Vrisaner, of Chavanne and Simon, and of Tizard and Marshall.
[51] Ind. Eng. Chem., 19, 229 (1927).
[52] J. Inst. Petroleum Tech., 12, 221 (1926).
[53] Ibid., 11, 533 (1925).
[54] Ibid., 12, 48 (1926).
[55] Clough & Johns, Ind. Eng. Chem., 15, 1030 (1923).
[56] Brooks, Chem. Rev., 11 (January, 1920).
[57] Davis and Murray, Ind. Eng. Chem., 18, 844 (1926).

lease of pressure the ethylene is released. The ethylene is then brought into reaction with hypochlorous acid.

This company's synthetic products are going into wide use. George Curme has taken a leading place in the development work.

Amyl Acetate From Gasoline

George Koch and the writer have made amyl acetate[55] from the pentane fraction of natural gas by chlorinating the fraction in the presence of activated charcoal and esterfying the fraction with sodium acetate under pressure, again with activated charcoal.

The reactions are:

$$C_5H_{12} + Cl = C_5H_{11}Cl + HCl$$

and $$C_5C_{11}Cl + Na\ (C_2H_3O_2) = C_5H_{11}\ (C_2H_3O_2) + NaCl$$

Amyl acetate is also made by the Sharples Company at Charleston, W. Va., from pentane through amyl alcohol.

Conclusion

In the writer's opinion the research problem of primary importance in the whole petroleum field, and one that is still largely unsolved, has to do with the isolation and identification of the compounds present in petroleum, both in the crude oil and in the distillates more or less altered by destruction distillation. The entire $500,000 donated by John D. Rockefeller and the Universal Oil Products Company, to be expended under the auspices of the American Petroleum Institute, could be well applied to this problem. Even so, only a fraction of the needed information would be acquired.

[55]Ibid., 19, 422 (1927).

Beneath every operation in the refinery lie fundamental considerations such as the writer has attempted to outline in this dissertation. The more these fundamentals are understood the more efficient will refinery operation become. It is true that refinery operations have largely developed without them, except for activity in research work of the chemistry of petroleum and refinery operations will be wonderfully helpful.

Excellent work has already been done by a host of investigators, but much more remains to be done. But this is probably true of everything. Thirty years ago the physicists thought their work had been reduced merely to the making of refined measurements, but a new field of entrancing problems has opened up since that time.

Analytical chemistry has long been considered the drudgery of chemical science, but more than anything else there is needed recognition of its important role in petroleum research. Until our methods of analyzing petroleum and its products are improved, progress in the chemistry of refining, or in the manufacture of petroleum by-products or new products, will be hampered. Training of high degree in analytical chemistry, coupled with a thorough knowledge of organic chemistry is essential in attacking the problems awaiting solution.

High temperature coal tars have yielded a rich reward for the research work expended on them. The problem of identification was considered almost helpless at the start. So it is with petroleum products. The problem is difficult now, but in 25 years we will look back over a vast field of accomplishment.

Tests Show Sulphur Content of Different Fractions

By H. L. KAUFFMAN

IN the petroleum refining industry the corrosion of equipment is one of the most frequent problems that must be solved. Due to the high temperatures attained in the cracking of oils, corrosion is particularly rapid in equipment used for said cracking. In a large number of instances, sulphur is the essential component of an oil that tends to make corrosion more rapid.

Because of this corrosion-tendency of high sulphur-containing oils, the results of sulphur determinations made on various fractions of an oil high in sulphur content and one relatively low in sulphur should be of interest.

The oils taken for test were Lander, Wyoming, crude oil having an original sulphur content (by the bomb method) of 3.16 per cent and Lost Soldier, Wyoming, crude having a sulphur content (also determined by the bomb method) of 0.23 per cent.

Lander crude is a black oil, asphaltic in its characteristics (wax, however, being present also), containing a relatively large amount of sulphur. Lost Soldier crude is of a mixed-base type of crude petroleum, high in content of both asphalt and paraffin but containing only a relatively small amount of sulphur.

Typical tests on and results of analysis of Lander crude are shown below:

Gravity °A. P. I.	24.5
Color	Black
Cold Test	°F. Below minus 6
B. S. and Water	0.4 %
Sulphur	3.16%

Summary of Yields

Product	Per Cent of Crude	Gravity of Product °A. P. I.
Gasoline	13.5	52.5
Kerosene	7.4	40.0
Gas Oil	16.9	32.8
Wax Distillate	25.0	24.6
Fuel Oil (bottoms)	36.0	9.1
Loss	1.2	...
Total	100.0	

Tests on the different products obtained from Lander crude, when the yields are as shown above, follow:

Gasoline

Gravity °A. P. I.	52.5
Distillation Test:	
Initial boiling point	174
10	244
20	270
30	288
40	307
50	326
60	340
70	354
80	370
90	388
92	398
95	410
97	426
End Point	434
Per cent off at 221° F.	7.0
Per cent off at 284° F.	28.0
Per cent off at 380° F.	86.0
Per cent off at 392° F.	91.5
Per cent off at 410° F.	95.0

Kerosene

Gravity ° A. P. I.	40.0
Flash—Cleveland Open Cup °F.	175
Fire—Cleveland Open Cup °F.	195

Gas Oil

Gravity °A.P.I.	32.8
Flash—Cleveland Open Cup °F.	255
Fire—Cleveland Open Cup °F.	290

Wax Distillate

Gravity °A.P.I	24.6
Flash—Cleveland Open Cup °F.	340
Fire—Cleveland Open Cup °F.	390
Cold Test °F.	61

Fuel or Road Oil Stock (Bottoms)

Gravity °A.P.I.	9.1
Flash—Cleveland Open Cup °F.	545
Fire—Cleveland Open Cup °F.	625
Cold Test °F.	96

In obtaining the percentage figures

TABLE I

Per Cent of Sulphur in Fractions from Lost Soldier and Lander, Wyo., Crude Oils

Particular Fraction Tested for Sulphur		Per Cent of Sulphur Contained in		Maximum Oil Temperature Reached in distilling each fraction	
Lost Soldier	Lander	Lost Soldier	Lander	Lost Soldier	Lander
0-10%	0-10%	0.014%	1.27%	440°F.	450°F.
10-20	10-20	0.020	0.70	520	495
20-30	20-30	0.029	1.09	570	550
	30-38	....	2.34		575
30-40	....	0.207	....	600	
	38-48	....	2.95		605
40-50	....	0.315	....	610	
	48-58	....	3.32		655
50-60	....	0.513	....	610	
	58-63.3	....	3.43		
60-70	....	0.530	....	605	
70-76-3	....	0.607	....		
	63.3-100.0	....	4.18		
76.3-100.0	....	Not determined			

Note.—Per Cent of Sulphur in original crude: Lost Soldier,0.23; Lander, 3.16.

shown above, a 15,000 cc. sample was taken for the primary fire and steam distillation of the crude. The results of this distillation are shown below:

Fire and Steam Distillation of 15,000 *cc. of Lander Crude*

Per Cent Off	Still Temp. °F.	Stream Grav. °A.P.I.	Product
10	450	53.8	Re-run Distillate
20	495	42.5	" "
30	550	36.1	" "
38	575	31.9	" "
48	605	27.5	Wax Distillate
58	655	23.5	" "
63	...	...	" "
36	...	...	Bottoms
1	...	...	Loss

The "re-run distillate" cut, representing 38 per cent of the crude, was then re-run in a short-necked, round-bottomed flask, fitted with a Hempel column containing glass beads for a height of about six inches. The yields obtained upon distilling this re-run distillate cut are shown below:

Product	Grav. °A.P.I.	Per Cent of "Re-run"	Per Cent of Crude
Gasoline	52.5	35.5	13.5
Kerosene	40.0	22.0	7.4
Gas Oil (Bottoms)	32.8	42.0	16.9
Loss	...	0.5	0.2
Total		100.0	38.0

Typical tests on and results of analysis of Lost Soldier crude are shown below.

Gravity °A.P.I.	30.5
Color	Greenish Black
Cold Test °F.	66
B. S. and Water	0.3 %
Sulphur	0.23%

Summary of Yields

Product	Per Cent of Crude	Gravity of Product °A.P.I.
Gasoline	8.0	52.7
Naphtha	2.8	44.5
Kerosene	3.0	39.3
Gas Oil	26.0	34.7
Wax distillate	28.3	31.7
Fuel oil (bottoms)	30.8	20.6
Loss	1.1	...
Total	100.0	

Tests on the different products obtained from Lost Soldier crude, when the yields are as shown above, follow:

Gasoline

Gravity °A.P.I.	52.7
Distillation test.	
Initial boiling point	166
10	198
20	209
30	218
40	226
50	235
60	245
70	258
80	272
90	296
92	303
95	315
97	336
End Point	350
Per Cent off at 221° F.	33.0
Per Cent off at 284° F.	86.5

Naphtha

Gravity °A.P.I.	44.5

Kerosene

Gravity °A.P.I.	39.3
Flash—Cleveland Open Cup °F.	120
Fire—Cleveland Open Cup °F.	135

Gas Oil

Gravity °A.P.I.	34.7
Flash—Cleveland Open Cup °F.	205
Fire—Cleveland Open Cup °F.	230
Cold test °F.	9

Wax Distillate

Gravity °A.P.I.	31.7
Flash—Cleveland Open Cup °F.	205
Fire—Cleveland Open Cup °F.	230
Cold test °F.	69

Fuel Oil (Bottoms)

Gravity °A.P.I.	20.6
Flash—Cleveland Open Cup °F.	470
Fire—Cleveland Open Cup °F.	540
Cold test °F.	109
Color	Black

In obtaining the percentage figures shown above, a 1500 cc. sample was taken for the primary fire and steam distillation of the crude. The results of this distillation are shown below:

Fire and Steam Distillation of 1500 *cc. of Lost Soldier Crude*

Per Cent Off	Still Temp. °F.	Gravity of Cut °A.P.I.	Product
5	300	54.7	Re-run distillate
10	320	45.7	" "
15	330	41.0	" "
20	345	35.9	" "
25	370	...	" "
30	390	34.2	" "
35	405	33.8	" "
40	430	33.5	" "
68.3	530	31.7	Wax distillate
30.8	...	20.6	Bottoms
0.9	...	...	Loss

The "re-run distillate" cut (39.1 °A.P.I. gravity), representing 40 per cent of the crude, was then re-run in a short-necked, round-bottomed flask, fitted with a Hempel column containing glass beads for a height of about six inches. The results of this distillation test are shown below:

Hempel Distillation of Re-run Distillate from Lost Soldier Crude Oil

Per Cent Off	Gravity of Cut °A.P.I.	Vapor Temp. °F.	Product	Per Cent of Re-run	Per Cent of Crude	Gravity of Product °A.P.I.
5	58.9	...	.....	...	...	...
10	55.0	...	.....	...	...	...
15	52.2	...	.....	...	...	...
20	48.7	302	Gasoline	20.0	8.0	52.7
25	45.5	...	.....	...	...	...
27	43.7	336	Naphtha	7.0	2.8	44.5
34.5	39.3	...	Kerosene	7.5	3.0	39.3
64.9	34.7	...	Gas Oil	64.9	26.0	34.7
0.6	...	...	Loss	0.6	0.2	...

With the results of tests and analysis on the two crudes under discussion clearly in mind, the reader is now referred to an examination of Table I, showing the percentages of sulphur present in fractions from each crude.

Sulphur determinations were made on the first three cuts of the Lost Soldier crude by the "burning method"; all other sulphur determinations made were by the "oxygen-bomb method."

The higher sulphur content of the first fraction from Lander crude is probably due to the presence of free hydrogen sulphide.

A "check-up" of the total amount of sulphur present, calculated from the sulphur content of the different fractions, with Lander crude, shows 2.81 per cent as compared with 3.16 per cent found by a direct determination of the sulphur content of the original crude oil. This difference can be due to the escape of the hydrogen sulphide gases during distillation. A similiar "check" on Lost Soldier phur content of the residual bottoms, uncrude could not be made because the sulintentionally, was not determined.

L. J. Morris has been appointed superintendent of the Wickett, Texas, refinery of the Bluebonnet Refining Company, succeeding I. B. Chittenden, resigned.

Pryse, Ky.—Refinery of The Texas Company here is to be shut down for the purpose of giving the plant a general reconditioning and for the installation of Holmes-Manly cracking units. Operations will be resumed some time later this year.

Mental Qualifications for Foremanship

By W. E. REARDON*
Superintendent

THE mental qualities a foreman should have are: Intelligence, general knowledge, memory, the power to grasp new ideas, alertness, reasoning power, constructive imagination, powers of observation, patience, ability to concentrate, foresight, power to learn, ability to express ideas and general education.

It is desirable for a foreman to have at least a high school education, and there are ways to obtain this same mind development outside of regular schools. Lack of schooling is not always a certain indication of lack of education. Education is a very broad term. In general, we may say that all experience is educational and that school is just one kind of experience. Too often a person with little schooling is inclined to underestimate his own education, for, after all, the effectiveness of a school education in the development of a man depends upon his natural mental capacity. A practical test of a man's education is his open-mindedness, and we might say that a foreman's education should be such as to give him a fund of general knowledge; a mind trained to solve problems; the ability to reason to a logical conclusion and a mind that is always open.

Every day of a foreman's life he is required to act as a judge, and he needs judgment to choose between the right and wrong of many situations. His men often form wrong opinions about certain things because they are not in possession of all the facts of the case, and it is the foreman's duty to tear down these false notions, prejudice and unsound beliefs among his men. To do this, he must have the ability to think straight.

As the foreman is called upon to carry in his mind a great many instructions, specifications and orders, a poor memory is a handicap to him. He can afford to spend a good deal of time and effort in developing his memory, if for no other purpose than he shall never forget a promise to his men. To forget a promise is to break faith. The men will not give the foreman the benefit of the doubt, but are apt to assume that he has intentionally given them a "raw deal."

As a leader of men, a foreman should be outstanding in his ability to grasp a new idea. A person who is slow to understand often has the ability to retain an idea after he once has it, but a foreman who absorbs ideas slowly is often misjudged not only by those above him, but by men under him.

A foreman should be wide awake and alert. He should be the type of man who gets to things before they get to him. If he allows his problems to get to him before he gets to them, he multiplies his difficulties, and makes more work for himself. If he is to keep his department on an even keel, he must know what is going on. Unless he is alert, many things will escape his attention.

Originality is hailed as a rare quality. If some one else will lead, it is easy to follow. A clever plan or method appears simple after some one else has originated it. Therefore, a good foreman should have originality.

When things go wrong a foreman needs to be resourceful. The ability to think of ways around, or over obstacles is a priceless possession. It is also a faculty which calls for constructive imagination. Every problem is solved by the use of constructive imagination.

A practical working knowledge of human nature should be a part of every foreman's mental equipment, as his ability to secure the co-operation of his men is based upon his knowledge of human nature. There is probably no better way to obtain a knowledge of human nature than to obtain a knowledge of one's self. A foreman can assume, with a fair degree of certainty, that his men have very nearly the same feelings, desires, appetites, impulses and pleasures that he has. Upon this fundamental fact the most important single principle of handling me nis based. This principle has been referred to in previous papers—"Treat a man as you would like to be treated." In order to obtain a better knowledge of one's self, the Kansas City Teachers College has drawn up a practical self-analysis for individual use, but in order to secure an unbiased rating, they recommend that you ask some intimate friend to check your rating by answering the 10 groups of questions which follow:

Personal Rating

1. Neatness. Are my habits of personal cleanliness the best? Do I dress suitably? Do I keep my personal effects orderly?

2. Broad-mindedness. Am I ready to recognize worth in others? Have I respect for the opinions and beliefs of others? Have I the ability to consider both sides of the question?

3. Courtesy. Do I try to manifest a real spirit of thoughtful kindly helpfulness? Do I avoid practices that make me conspicuous?

4. Dependability. Am I punctual in meeting all engagements? Am I trustworthy about meeting obligations to the best of my ability?

5. Loyalty. Have I a sense of responsibility for the welfare of the business in which I am engaged? Do I make my personal interests secondary to my business interests? Have I a real respect for my occupation?

6. Co-operation. Have I the ability and willingness to work with others? Have I a real desire to be helpful in all situations?

7. Leadership. Have I the ability to plan and carry out projects of various sorts? Have I the ability to win the allegiance and co-operation of others?

8. Honesty and Sincerity. Have I the strength to be honest under all circumstances? Am I straightforward and unaffected?

9. Perseverance. Have I the ability to stay with a task until it is finished? Have I a tenacity of purpose, even against great odds?

10. Self-Control. Have I the ability to hold the mastery of myself under trying circumstances? Have I the ability to be pleasant and considerate, even though others are unfair and irritable?

It is not easy for a person to make an accurate analysis of himself, but by following out the instructions in regard to the above list of questions, a person will become better acquainted with himself, and, as a result, will be better fitted to handle men.

Patience Required

A foreman should be patient. The excitable foreman who "gets on his high horse" does not command the respect of his men. Although the fact that he has been placed in charge of the men indicates that he has certain qualifications which

*Paper Presented at Columbian Gasoline Corporation's Foremen's meeting.

better fit him for the position, the foreman can learn many things from his men. A foreman cannot expect his men to use as good judgment as he does. They will not grasp new ideas so rapidly as he will. But, it is only natural for the foreman to expect a little more from his men than he receives. These are conditions that require his utmost patience.

A foreman who has a real desire to increase his store of knowledge will always be in the process of growth. No foreman should be satisfied to stand still. He must keep at least one step ahead of the men under his supervision.

To be a good foreman a man must be observing. His mind should be charged with how's, when's, why's, where's and who's. He will observe the habits of his men. He will observe all details of the work.

A better knowledge of the responsibilities of citizenship broadens the foreman's point of view and marks him as an outstanding man among the workers.

The possession of a store of general knowledge, good, judgment, intelligence, foresight, patience, and knowledge of human nature will make of a foreman a logical leader of men.

The Plant Manager's Part in Accident Prevention

By C. W. PRICE

Director, Training Course for Safety Engineers, New York University

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WHY is it that notwithstanding the remarkable accomplishments in accident prevention attained in hundreds of individual plants, industrial accidents over the United States as a whole are increasing?

Is it because employers of labor are indifferent to human suffering and care nothing for the welfare of their employees and their families? Not at all. In my work during the past 20 years I have had to deal with general managers of industry nearly every day, and I have not met a half dozen industrial managers who were indifferent to human suffering.

Where inefficient safety work—or no safety work—is being done I have found in practically every case in my experience that this is the situation: the manager is an intelligent, decent, human sort of a person and he regrets that he is having so many accidents; he is not doing efficient safety work because he is not informed; he doesn't know, from first-hand experience, what has been accomplished elsewhere; he doesn't believe that accidents can be prevented because he doesn't know how that is being done.

How is such a manager to be convinced and aroused so that he will take steps to develop a thorough-going, efficient safety organization in his plant? I have found that three things are necessary to convince such a manager. First, place before him the experience of a number of companies that have made substantial reductions in accidents and show him the financial gain. Then you have not convinced him; you have only interested him! That is to say you have not convinced him sufficiently to make him act. The second step is to tell him very simply, in detail, about the methods used in accomplishing these results, so that he will say when you have finished, "That is simple; we can do it." The third step in getting this manager to set in motion a thorough-going safety organization is to help him sell the idea to his foremen and employees and to acquaint them with all of the details of the plan.

Three qualifications are indispensable to a manager who whould successfully promote safety in his plant. He must believe in safety as a good business proposition; he must put it on the map and get back of it and stay back of it so unmistakably that not a foreman or a workman will doubt for a minute what he, the manager, proposes to do and what he expects them to do; he must not only initiate the campaign but he must continuously, day in and day out, closely identify himself with the safety activities. Half-hearted cooperation on the part of the manager will accomplish nothing.

There are five specific activities in an accident prevention campaign for which a manager should make himself responsible if he wishes to accomplish in his plant the most that can be done to save men and money through accident prevention.

First, it goes without saying that before very much can be done to secure the whole-hearted cooperation of workmen, a manager must give unmistakable evidence of the fact that he is going to do his part. It is obvious that the first step in this direction is to eliminate hazardous physical conditions in the plant by means of mechanical guards and improving physical equipment. If, for example, during the inauguration of a safety campaign, one serious accident occurs in a plant, due to the lack of a mechanical guard, which might have cost five or ten dollars, it is pretty difficult to convince the workmen that the manager really means business.

Next, the manager must sell the safety idea to his foremen and must secure their whole-hearted cooperation. It has been found that by far the most effective way of lining up the foreman and keeping them intelligently interested is through a series of monthly meetings of foremen, at which the manager presides. Such meetings offer a splendid opportunity for the manager, each month, to impress upon his foremen the fact that the protection of huamn life must be given first place in their day's work, and that he, the manager, and the officers of the company stand ready to do anything which will help to make the plant safe. These meetings also offer an opportunity for a mutual exchange of experience and for the consideration of the previous month's accident record and ways and means of preventing similar accidents.

Third, the manager should make it his business to familiarize himself with every accident of any importance and should take a personal interest in any employee who is seriously injured.

Fourth, the manager should frequently send his personal message concerning safety directly to all of the employees under him. An effective method is to prepare a letter or other message over the actual signature of the manager, and to post this prominently on the bulletin board, once a month. Such letters should deal with some important phase of accident prevention. If opportunity offers the plant manager or company president should congratulate the workmen on any good record, or if there has been some flagrant violation resulting in a bad record he should call their attention to it. In every letter he should express his own interest in safety and his willingness to do everything in his power to protect employees.

Finally, the manager should encourage foremen and workmen whenever opportunity presents itself by expressing verbally or in writing his appreciation of any valuable suggestion or any meritorious effort in the direction of accident prevention or health promotion.

The accident prevention campaign offers a unique opportunity for a manager to show the sort of leadership that will not only win the confidence of foremen and workmen and thus develop a better morale and that will not only improve the accident record, but will increase the general efficiency of the plant and better the relations between management and men.

The Hydrogen-ion Test Applied to Acid Sludge Emulsions

By L. J. CATLIN
The Standard Oil Company, Kansas

DISPOSAL of acid sludge emulsions is a vexing problem at most refineries. Dumping in sewers is not only out of the question from the standpoint of stream polution, but must be looked upon as uneconomic, because aside from the acid lost, it represents fuel value which might be turned to good account. Burning seems the more economic method, but the large amount of water in the emulsion which must be evaporated, largely offsets the fuel value of the oil, and usually necessitates the addition of more fuel oil before it will support combustion in the ordinary oil burner. Impounding in reservoirs awaiting a high stage in rivers is merely dodging the issue.

In a previous article* mention was made of the method used by a good many refiners, of neutralizing the acid in these emulsions with various caustic solutions, including spent caustic from other parts of the treating system. A great deal of oil may be recovered from these emulsions in this manner, but it is difficult to get the emulsion to break unless the neutralizing process is stopped at just the right point. Too much caustic seems to produce a complex emulsion in all probability causing a partial reversal of the emulsion, with oil dispersed in water, and this water-oil system still further dispersed in oil. The fact that good separation is attained near the neutral point leads to further investigation for a method of more accurately determining the degree of acidity or alkalinity of the mix.

Breaking the Emulsion

Various indicators were used. As previously mentioned, litmus paper may be used in the coarser determinations if it is first wet with water to protect it from oil wetting till the water particles in the emulsion have time to reach the indicator. As the neutral point is approached these dispersed particles become increasingly hard to reach, and this method fails. Adding such indicators as methyl orange and phenolphthalein to the emulsion is of no avail because if they do reach the water particle they can not be seen because of the encasing oil film. It will be shown later that they are not suitable indicators for this reaction anyway.

It seemed necessary, therefore, to break the emulsion for the purpose of the test, and the following method has proven quite satisfactory.

In a small separatory funnel place about 10 or 15 cc. of acetone, and add a few drops of the emulsion to be tested. The amount that will adhere to the end of a stirring rod is sufficient, and may be washed off in the acetone. Shake vigorously for a few minutes till a thorough mixture is obtained. Add distilled water in an amount about double the amount of acetone used and again shake vigorously. Allow a few minutes for settling and then withdraw some of the water portion for testing. For obtaining the degree of acidity or alkalinity at this point, the author has had excellent results using indicators and color standards used for hydrogen-ion determination as sold by the La Motte Chemical Products Company. A small pocket set containing three indicators is designed for soil testing, furnishes sufficient range for use after litmus papers fail to give an indication. About 10 drops of the water from the separatory funnel are placed in a small test tube furnished with the set and made up to the mark (about 10 cc.), and one drop of indicator added. After mixing thoroughly, this is compared with color standards, also furnished with the set, and the hydrogen-ion concentration read off the chart.

The use of these indicators has proven that the most favorable point for breaking of the emulsion is at the neutral point, or within a range not greater than pH 6.4 to 7.6, netural point being pH 7.0.† Reference to a chart showing the range of various indicators, as published by the above mentioned company, shows that methyl orange and phenol-phthalein each fall short of indicating the exact netural point, far beyond the degree of accuracy evidently demanded by this operation. Litmus covers a range, and might be used if proper color standards were prepared for it. Its range, however, is a little too broad for the proper degree of sensitiveness, and is covered more thoroughly in the set referred to by three indicators; chlorphenol red, bromthymol blue and phenol red.

An attractive feature of the test here described is the fact that a sample of emulsion as taken may contain portions of both acid and alkali which have not yet reached each other, and yet the result after they are brought together will be represented in the finished test. This allows almost immediate testing after addition of one of the reacting materials.

In using spent caustic solutions it has been pointed out that care must be execised to avoid generation of hydrogen sulphide gas, with consequent danger to operators. It has been found, however, that by using very dilute solutions so that the rate of generating the hydrogen sulphide is greatly reduced, this danger is minimized to a degree where it may be safely practiced, especially in outdoor vessels where the operator has plenty of air circulation. In recent tests where H_2S had been absorbed from oil in caustic of about 5 Baume gravity, only slight traces of H_2S could be found emitting from the acid emulsions being treated. The following possible reactions may furnish an explanation in this case, where the rate of generation is comparatively slow.

$$H_2SO_4 + Na_2S \rightarrow Na_2SO_4 + H_2S$$
$$H_2S + H_2SO_4 \rightarrow 2H_2O + SO_2 + S$$
$$2H_2S + SO_2 \rightarrow 2H_2O + 3S$$

By these reactions hydrogen sulphide is oxidized to water and free sulphur. Sulphur dioxide, SO_2, is often plentiful in acid sludge emulsions due to the reducing action of hydrocarbons on sulphuric acid. This suggests the desirability of washing the acid out of the sludge as soon as possible after drawing it. Such a procedure not only saves acid, but makes for easier breaking of emulsions by preventing polymerization and dehydrogenation of the hydrocarbons, resulting in heavier pitch in the place of the lighter original oils which go to make the oil phase of the emulsion.

In any case where caustic solutions are to be utilized, caution must be exercised, and tests of the atmosphere frequently made by the laboratory, or some one qualified to guard against possible danger. The savings possible will no doubt justify such additional precaution. Another advantage is found in the use of weak caustic solutions for finishing the neutralization, in that there is less danger of going beyond the neutral point, and less tendency to reverse the emulsion in case too much caustic is added.

*The Refiner, Vol. 7, No. 6, June, 1928.

†The ABC of Hydrogen-ion Control, La Motte Chemical Products Co., Baltimore, Md.

Notes on Drip Gasoline

By ALEXANDER B. MORRIS

EVER since the first commercial use of casinghead gas, drip gasoline has been a source of much trouble to all concerned with handling this commodity. Whereas it is to some a source of considerable profit, it is probably safe to say that for most operators, whether producers or manufacturers, the cost of collecting it so closely approximates the value of the gasoline collected, that they would be glad indeed if it did not accumulate in their lines.

In spite of the unfailing presence of "drip" in the gas gathering lines of all companies, so little has this figured in the literature that last fall when it became expedient to know something definite in regard to drip formation, the writer was unable to find anything in any way bearing on the subject. Some original research was therefore necessary, and though it was not possible to carry this to as great detail as would be desirable, still some very interesting facts were developed. A few of these are set forth below, and it is hoped that at a later date it may be possible to augment these with others which will make all the information of much more general utility.

In carrying out this study, a plant in a rich gas region was selected. "Drip" accumulations are heavy at all seasons in this field. First a map was made upon which were located all gathering lines and drips. Key designations were assigned to each drip and forms prepared and put into use for recording the daily production from each drip. Gasoline was blown from the drips by air pressure, and caught in drums on a truck which hauled it to the plant. Measurements are probably correct to within about five per cent. either way. No gauge was taken of the accumulation of water, though it was found later that this information would have been very nearly as interesting as the volumes of gasoline caught. Water was blown out on the ground and no estimate of its volume made.

During the winter and spring frequent samples were secured at each drip and notes made of the following conditions:

Air temperature.
Gas temperature.
Gasoline temperature.
State of weather.
Standard Engler distillation of sample.

Temperatures

The temperature readings established the fact that 45 degrees was approximately the average ground temperature during the winter months. These lines were mostly buried, at an average depth of one foot or a little less, but the drips are mostly four foot by six foot tanks, some set vertical and some horizontal, and in all cases buried so that the highest points are about one foot below the surface. In many cases the temperature of the gasoline in the drip, which had been accumulating for 48 hours or more, and the temperature of the flowing gas in the line, were the same at 45 degrees or thereabout, even in widely separated points in the field; and as this result only occurred when the data were obtained at points remote from vacuum stations, it is reasonable to suppose that this represents the minimum to which the ground will cool the gas. Where lower gas temperatures were obtained, it was found that the lines were uncovered for part of their length, and such lower gas temperatures were obtained only at times of notably lower air temperatures. Where temperatures much in excess of 45 degrees were found on the same days, the observation points were always found to be unduly close to a vacuum station discharge.

The condition under which the gas is collected in this field are as follows:

Vacuum of about 25 inches is maintained on the wells by the well owners. Gas is delivered to the gasoline company at the vacuum discharge scrubbers at about 10 inches of vacuum. This represents a compression ratio of roughly 5:1, and is attended by considerable heating of the gas. No artificial cooling of the gas is resorted to. Meters, at which settlement tests are made, are located anywhere from 100 to 1500 feet from the vacuum stations. A tank drip is located at the intake end of each meter. Other drips are located on the lines at necessary points.

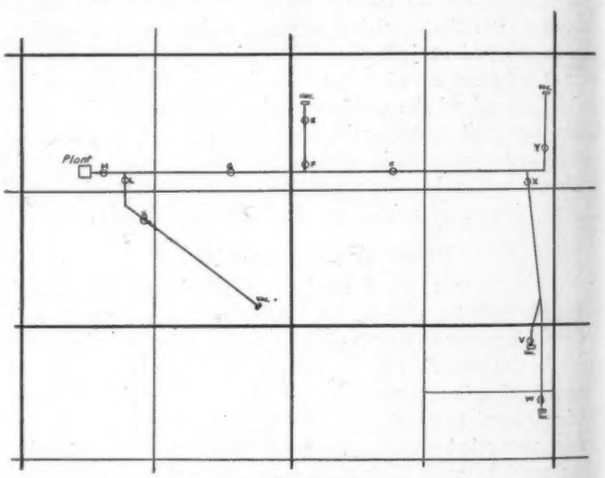

Figure 1

Figure 1 is a portion of the map showing one of the several lines leading into this plant, and the several branch lines off it. Table 1 shows the volumes of gasoline collected at each one of the drips on this line in November and in May, with the volumes registered at each meter and the physical test of the gas currently being used for settlement purposes. As a matter of fact, these settlement tests having been made in October and April respectively, the actual content of the gas in these months was lower in November and higher in May than these figures show. Figures 2 and 3 show standard Engler distillations of sam-

TABLE 1.

		NOVEMBER			MAY		
Drip	Location	Gall.	M. Cu. Ft.	Yield	Gall.	M. Cu. Ft.	Yield
W	Meter	1869	526	14.60	1877	568	11.10
Y	Meter	1775	922	18.30	1444	1279	11.60
X	Branch	2371	(1448)	....	3322	(1847)	....
Y*	Meter	6566	1415	10.90	5547	1627	8.00
C	Main	21	(2863)	....	....	(3474)	....
E	Meter	1686	1564	14.70	1185	1494	12.10
F	Branch	3204	(1564)	....	3705	(1494)	....
G	Main	172	(4427)	....	145	(4968)	....
K*	Meter	5788	2383	10.50	7130	2453	8.50
L	Branch	....	(2383)	....	....	(2453)	....
M	Main	663	(6810)	....	No Rec.	(7421)	....

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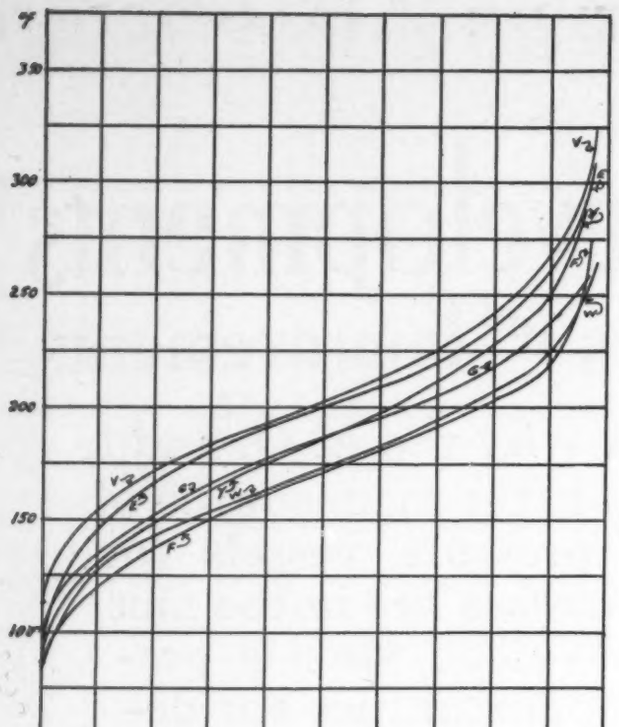

FIGURE 2
Distillation curves of winter samples. Letters refer to drips on map in Figure 1.

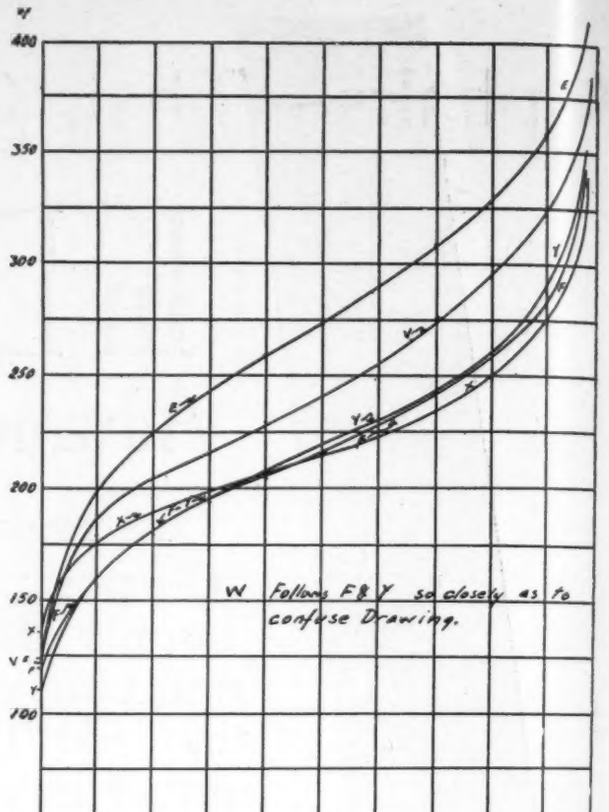

FIGURE 3
Distillation curves of summer samples. Letters refer to drips on map in Figure 1.

ples taken at these drips under winter conditions and under summer conditions respectively. Table 2 compares these samples quantitatively.

From this information it is possible to note the progressive change in the quality of drip gasoline at different points along the line as well as the seasonal change in quality of the accumlations at the same point.

Table 1 disclosed some rather surprising facts. It is generally supposed that the accumulation of drip gasoline is much greater in winter than in summer, and at first thought this seems perfectly reasonable. In fact it is undoubtedly true if all the drip caught between the casing-head and the gasoline plant were considered. That it is not true of any particular drip, however, is apparent from the table, and from similar data obtained on other lines leading into this plant. The drips located close to the vacuum discharge—including in these the discharge scrubbers—do indeed make much more gasoline during the winter months, but this condition is reversed with respect to drips located on the branch lines and on the main line, at which points it was found that warm weather accumulations exceeded cold. This is probably to be explained by the fact that in winter the gas receives sufficient cooling in passing through the discharge scrubbers and through the cold line up to the meters to bring condensation at the existing pressures almost to completion; whereas in the hot weather, this is not the case, and it requires the passage through several hundred feet more buried line in order to bring this about. Another contributing cause to this effect is probably the removal from the gas while under the high vacuum of a large part of its load of heavy fractions which are dropped in the vacuum lines of the well owner and in winter never even reach the vacuum station.

In summer, the heated ground prevents these fractions from being dropped until after passage through the vacuum pumps, whence they emerge in the form of a fine mist. That such a mist actually does exist in some of the lines is proven by a mist extractor placed at the intake to drip E. This was frequently gauged and showed an average recovery of about 40 gallons of gasoline per day in addition to what dropped out in the line and was drained off through a separate syphon line. Distillation of two samples of the product of this mist extractor showed I. B. P.'s of 172 and 180 degrees respectively.

(Continued on page 98)

TABLE 2

Drip	Date	Temperatures Gr. Air Deg.	Gas Deg.	Gaso. Deg.	oBe. Deg.	I.B.P. Deg.	Distillation Data °F 20% Deg.	50% Deg.	90% Deg.	E.P. Deg.	Recovery %
W	1-20-28	26	42	..	70.5	93	141	173	224	265	98.0
	6-23-28	83	85	..	63.6	112	179	216	288	360	98.5
V	1-20-28	30	55	44	67.8	85	149	183	250	285	96.0
	6-23-28	84	101	..	59.0	122	204	235	322	386	98.5
Y	1-28-28	38	41	..	70.4	85	146	186	248	290	96.5
	6-23-28	81	82	..	63.4	112	182	220	290	351	98.0
X	7-23-28	96	..	..	62.5	136	187	214	276	340	98.0
E	1-21-28	36	42	..	66.1	88	167	215	257	301	97.5
	6-23-28	81	105	..	57.1	124	224	272	358	410	97.5
F	1-27-28	..	..	..	71.9	85	136	170	220	272	97
	7- 3-28	96	..	..	63.1	118	180	216	282	342	98
G	1-19-28	51	..	51	68.7	100	153	184	238	lost	
K	1-21-28	37	40	47	70.2	88	148	184	241	293	97
	3-16-28	..	..	..	69.8	86	152	190	264	308	97
	6-23-28			..	...	..	...	...	...	...	...

Asphalts—Their Origin, Manufacture and Uses

By GEO. W. CUPIT, Jr.
Chemical and Refining Engineer

THIS is the first part of an exhaustive inquiry in asphalts. While considerable of it deals with the history of these products, this preliminary matter leads into the subject of manufacture.

Part two will discuss residual asphalts, sludge asphalts, as well as the manufacture of each grade already considered on a commercial basis.

THE term asphalt was first used by the Babylonians and later by the Greeks. From the Greek, the word passed into Latin, and thence into French (asphalte) and English (asphalt). The earliest recorded use of asphalt was by the inhabitants of the Euphrates Valley about 3000 B.C. These people were skilled in carving and decorating stone. In many specimens recently unearthed are found bits of stone and even shells cemented in place by means of asphalt. A number of these specimens are still in an excellent state of preservation. Upon analysis of these asphalts the following results were obtained:

Moisture—2.8 per cent.
Asphalt—24.4 per cent.
Mineral Matter—71.2 per cent.
Wax—1.6 per cent.

The mineral matter, was composed of the sulphates, carbonates and phosphates of calcium and the oxides of iron, aluminum and silicon.

Of all the Babylonian rulers, Nebuchadnezzar, who reigned 604-561 B.C., was the most progressive, and is stated to have reconstructed the entire city. The bricks that he used bore inscriptions relating to his work, and several refer specifically to the use of asphalt. This would seem to be the forerunner of the present-day pavement composed of stone blocks set in asphalt. It seems strange that the art should have become lost to mankind, only to be rediscovered in the nineteenth century.

So far, I have used the term asphalt as applied to natural rock asphalt. Later I shall discuss asphalts, their manufacture and uses, as applied to petroleum. The earliest case on record of rock asphalt being used in the United States for side walks is in the portico of the old Merchants Exchange Building in Philadelphia in 1838.

Terminology and Classification

Due to the nature of the subject, one of the most difficult problems with which we have had to deal in recent years is that of fixing the definitions of the various bituminous substances.

At first nothing was known regarding the properties—(physical or chemical) of these substances. The words asphalt, pitch, bitumen were used interchangeably. These at first had a limited meaning but as new substances and products were discovered, they were extended in scope until the various expressions outgrew their bounds. This resulted in a certain amount of ambiguity. On account of the chemical complexity of these substances we have been compelled to rely principally upon the physical characteristics and tests in arriving at a rational basis of terminology. Therefore, in defining we must rely on one or more of the following: origin; physical properties; chemical composition, and solubility. An examination of the substance itself will enlighten us on the last three mentioned.

In order to permit of its identification without necessarily having prior knowledge concerning its origin, we can base the definition upon the inherent characteristics of the substance. The *first* is origin, and falls within three headings: mineral, vegetable, animal. The *second* is, physical properties. Under this heading belong, color (light or dark) consistency. In this case it may be liquid viscous semi-solid or solid; luster, resinous, waxy, brilliant or dull; Feel—Adherent or non-adherent; Volatility—volitile or non-volatile; Odor—Oily or tarry—by oily I mean petroleum-like; Fusibility—fusible, difficultly fusible, and infusible (melts only with decomposition).

The *third* is chemical composition.—Compounds containing carbon and hydrogen; compounds containing carbon, hydrogen and oxygen, (oxygenated bodies); mineral matter, such as inorganic substances; crystallizable compounds especially at low temperatures.

From the above outline it will not be difficult to define a few of the more important terms in order to fully comprehend that which is to follow.

Bitumen—This is a generic term applied to native substances of variable hardness, color and volatility; which are composed of hydrocarbons essentially free from oxygenated bodies; sometimes associated with mineral matter, the non-mineral constituents being easily fusible and for the most part soluble in carbon bisulphide, and whose distillate fractionated between 300 and 350 degrees C. yields a sulphonated residue.

Pyrobitumen—A term, applied to native substances of dark color, comparatively hard and non-volatile; composed of hydrocarbons, which may or may not contain oxygenated bodies, sometimes associated with mineral matter, the non-mineral constituents being infusible and relatively insoluble in CS_2. This expression implies that the substance when subjected to heat or fire will generate, or become transformed into bodies resembling bitumens in their solubility and physical properties.

Petroleum—A species of bitumen, of variable color, liquid consistency, being comparatively volatile, possessing a characteristic odor, composed of hydrocarbons, essentially free from oxygenated bodies; soluble in CS_2, and whose distillate cut between 300-350 degrees C. yields considerable sulphonation residue. This definition includes mixed-base and asphaltic petroleums.

Asphalt—A term applied to a species of bitumen, also to certain pyrogenous substances of dark color, variable hardness, comparatively non-volatile; composed of hydrocarbons, free from oxygenated compounds; containing relatively little or no crystallizable compounds; sometimes associated with mineral matter, the non-mineral constituents being fusible, and largely soluble in CS_2; and whose distillate cut between 300-350 degrees C., yields considerable sulphonation residue. This definition is applied to native asphalts and pyrogenous asphalts. Native asphalts include asphalts occurring naturally in a pure or fairly pure state, also asphalts associated naturally with a substantial proportion of mineral matter. Pyrogenous asphalts include residues obtained from the distillation, blowing, etc., of petroleums, for instance, residual oil, blown asphalts, residual asphalts, sludge asphalts, etc. Oxygenated bodies, as mentioned above, include certain alcohols, fatty acids, phenols, resin, acids and water. The latter occurs in small quantities in all native petroleums and in most native asphalts, especially those asso-

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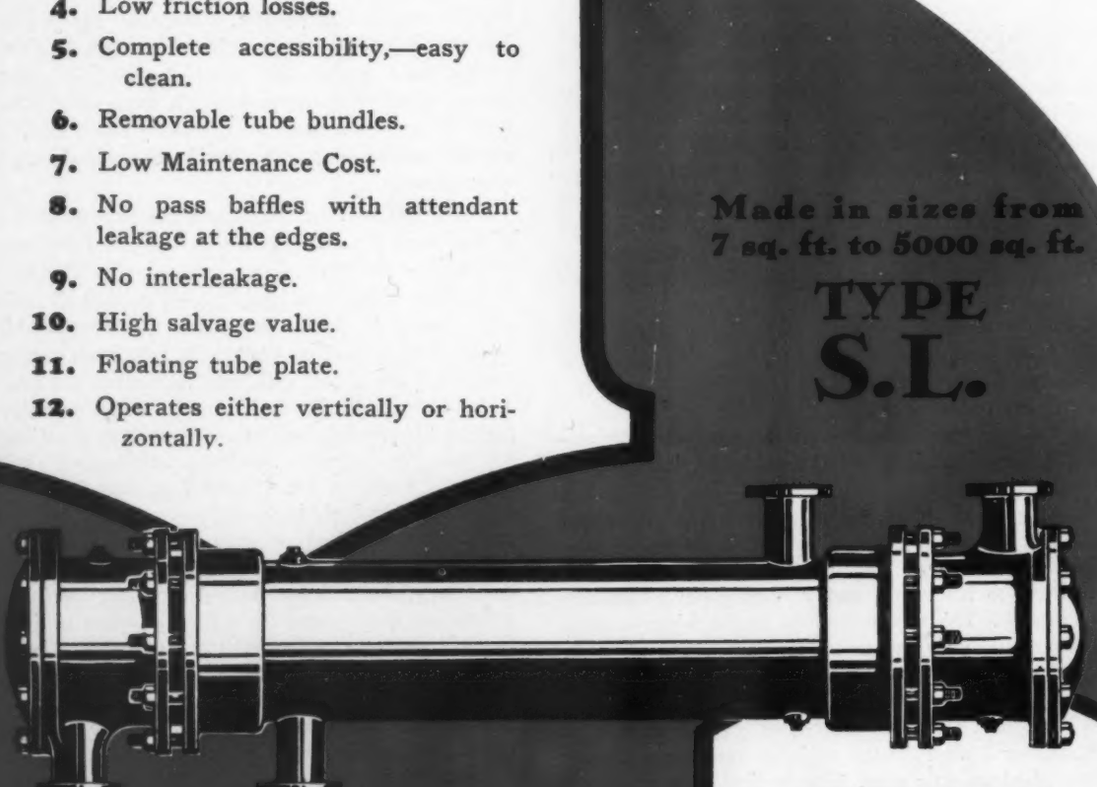

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ciated with mineral matter. Water is always present in crude tars, being formed by the combination of hydrogen and oxygen at high temperatures and pressures.

Movement of Bitumens

It is a singular fact that petroleum and asphalts are not always found in the same locality in which they originated. They possess the characteristic of migrating from place to place, and many deposits are still in the process of migration. A primary deposit is one in which the material is still associated with the same rocks in which it originated. A secondary deposit is one to which the material has subsequently migrated.

Bitumens usually migrate while in a liquid or melted condition, although in certain rare cases, the migration has been induced by the action of flowing water while the bitumen is in the solid state. The main causes for the movement of native bituminous substances in the earth's surface are: hydrostatic pressure, gas pressure, capillary, gravitation and effect of heat.

Hydrostatic pressure is largely responsible for the accumulation of petroleum in pools or reservoirs. At some distance below the earth's surface there is an accumulation of ground water, the level of which varies in lifferent localities and during different seasons. The petroleum being lighter than water, floats on its surface. As the level of the ground water varies, it will move the petroleum about through interstices in the rock. The water tends to push the oil ahead of it, and this will account for the accumulation of the petroleum in the form of pools underneath a cap of a dense and non-porous strata through which it cannot permeate. This will also explain why there is often an accumulation of petroleum in the ground near the top of a hill or mountain. Oil and gas are often encountered under pressure, due to the hydrostatic head of water.

Undoubtedly gas pressure is caused by the action of heat or other forces below the surface of the earth, which tend to partially vaporize certain bitumens, so that the resulting gases will force them into the overlying strata near the surface. In other instances the effect of crumpling, upturning, erosion and other movements of the earth's strata exposes the oil-bearing formations, and enable the gas pressure to force them to the surface. Natural gas exists under great pressure in certain localities. Many gas wells in Pennsylvania fields have registered a pressure of 600-800, and even as high as 1000 pounds per square inch. This may be accounted for by the fact that as the gas is constantly being generated, it accumulates inside the earth's surface and has no access to escape owing to the density of the strata above.

This force takes place in dry porous rocks and acts on permanently liquid bitumens or bitumens solid at ordinary temperatures but transformed to the melted state by the action of heat. Under these conditions the bitumen will soak into the pores of the rock or sand and gradually fill the interstices. Capillarity is a very much stronger force than gravity, although other froces, such as the action of heat may be partly responsible. The finer the pores in the rock, the greater the capillary force.

The natural weight of the overlying strata caused by gravitation sets up a pressure where there are accumlations of petroleum or other forms of liquid bitumen underneath, and if a fissure occurs in the earth's crust, the bitumen being softer than the surrounding rock, will be forced to the surface. Gravitation is, therefore, selective in its action and by exerting a greater pull on the heavier bodies will tend to force the lighter ones upward. Under other circumstances, where the substances are not confined, the result of gravitation is to cause the petroleum or liquid asphalt to ooze from the overlying rock matrix in the form of seepages.

The effect of heat is also a large factor in causing the migration of bituminous substances. Its effect is variable. Under certain circumstances it will convert the solid bitumens into a liquid state and thus enable them to be acted upon by the various forces considered previously. Under other conditions, heat in the interior of the earth will vaporize the bitumens such as petroleum and force them upward. Again, if the heat is sufficiently intense, it is apt to cause the bitumens to undergo destructive distillation, the distillate condensing in the upper and cooler layers.

Changes from Petroleum

There has always been a wide difference of opinion as to the origin of petroleum. However, authorities are pretty well agreed that petroleum when once formed, is gradually converted into other types of bitumen and pyrobitumens, under the influence of time, heat, and pressure. This process of transformation is known as metamorphosis.

It is contended that mineral matter in a finely divided form, such as colloidal clay, hastens this transformation by acting as a catalyst. In studying the well-known Trinidad asphalt lake deposits, Richardson concludes that an asphaltic petroleum existing at a considerable depth is converted into a more solid form of bitumen, namely asphalt, upon being thoroughly emulsified with colloidal clay, sand, and water through the medium of natural gas at a high pressure. The elements of time and temperature are equally important factors.

During the metamorphosis, hydrogen is gradually eliminated, the hydrocarbons becoming enriched in carbon, and from a chemical standpoint more complex structurally. The changes brought about during this process may be regarded as a form of polymerization, in which the hydrocarbon molecules become rearranged into more complex molescules of higher molecular weight. In petroleum exist the simplest of hydrocarbons, and they become more complex structurally in the case of asphalts and asphaltic pyrobitumens. There are no sharp lines of demarcation between the various types of bitumens. Each class gradually merges into another, and specimens will often be found on the border line, so that it is difficult to decide to which class they really belong. It is very probable that all deposits of asphalt are produced by metamorphosis from asphaltic petroleum.

The transformation manifests itself from a physical standpoint by:

An increase in hardness;
An increase in specific gravity;
An increase in the perecentage of fixed carbon;
An increase in fusing point;
A decrease in the percentage of volatile matter;
A decrease in the percentage of soluble in CS_2;
An increase in the flash and burning-points.

Although certain members are soluble in carbon bisulphide, yet as the metamorphosis progresses, the solubility decreases, and this is particularly noticeable in the case of asphaltic pyrobitumens.

Petroleum Asphalts

Petroleum as it occurs in different parts of the world, varies widely in composition. Certain classes of crudes are composed of open chain hydrocarbons, others are made up exclusively of cyclic hydrocarbons, while others occur showing every possible graduation between these two extremes. From the standpoint of the solid hydrocarbons present, petroleums may be divided into three groups:

Bearing a substantial quantity of solid paraffines;
Bearing a substantial proportion of asphaltic bodies;
Of mixed composition, bearing both solid paraffins and asphaltic bodies.

The solid paraffins are generally associated with open chain (aliphatic) hydrocarbons, and the asphaltic bodies with cyclic (aromatic) hydrocarbons.

Open chain hydrocarbons predominate in the petroleum crudes produced in Pennsylvania, New York, Kentucky and West Virginia. These, however, are non-asphaltic and generally contain solid paraffine. In Oklahoma, Illinois, Kansas and Northern Louisiana the crude oils porduced from these fields

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contain both the open chain and cyclic hydrocarbons and are, therefore, termed mixed-base crudes. These contain both asphalt and solid paraffine.

Cyclic hydrocarbons predominate in petroleums produced in the fields of Southern Texas, Southern Louisiana, California, Mexico and Trinidad. These are representative of the asphaltic petroleums, and are free from solid paraffines.

Residual Oils

The characteristics of residual oils and residuums obtained by the reduction of petroleum oils depend upon three factors, the nature of the petroleum from which they are produced; extent to which the distillation has been carried, and the care with which they have been prepared.

It may be helpful to mention here some of the disadvantages encountered in using petroleum crudes composed principally of aliphatic or paraffinaceous hydrocarbons where asphalt fluxes are desired. They are apt to show a separation at comparatively low temperatures. They do not flux with hard asphalts, and they are apt to show a separation of greasy matter. It should be noted that the residuums derived from asphaltic petroleum constitute the best residual fluxes.

Residuums from mixed base crudes may be divided into two main classes, namely, those derived from crudes produced in the United States and those derived from Mexican crudes. Those obtained from the latter may be differentiated from the former by a higher percentage of fixed carbon, a larger percentage of sulphur, and a lesser solubility in 88 degree Be naphtha. An important factor in arriving at the value of residuum for certain purposes is the percentage of volatile constituents. The greater the perecentage of volatile matter, the less durable it will be upon exposure to weather conditions. This is a very important factor when the asphalt residuum is used to flux harder asphalts, in which event it is desirable that the volatile constituents shall not exceed five per cent. at 500 degrees F. run for five hours. Residuums of this nature will withstand exposure remarkably well, either when used alone or n various combinations (as fluxes).

Blown Petroleum Asphalts

In part I of this work I shall discuss asphalts in general and shall reserve the manufacturing processes of same for Part II to be published in the near future.

Oxidizable asphalts are very peculiar products, and peculiar in many more ways than one. Their oxidation, by no means, follows the general rule. So peculiar are some of their reactions that one is apt to accept the belief that, in reality, the process is not one of oxidation after all, but one of polymerization and even condensation. By condensation is meant the reaction between, or coupling of, different classes of compounds such as aldehydes with phenols, or aldehydes with ketones, etc. These are examples of general organic reactions, the latter reaction being often referred to as the aldol-keto condensation. It is quite possible that such a reaction takes place, for it is a known fact that such organic compounds as are above mentioned actually exist in petroleum residuums. Various types and methods of oxidation have been used to acquire the desired results. For instance, potassium permanganate as well as permanganic acid, has been used for oxidizing residuums at a temperature of 300 degrees F. (De Smedt in "Asphalts and Allied Substances" by Herbert Abraham). The general and most economic method of oxidizing petroleum residues is that of blowing air through the residuum at a temperature of 400-600 degrees F. for the desired length of time.

The time factor is a very important one, since the melting point, brittleness, penetration, and resistance to changes in atmospheric temperature, are, to a large extent, dependent upon the time of blowing. A number of refineries reduce the asphalt base petroleum to a 100 degree F. melting point bottoms and then transfer the residuum to an oxidizer and blow at the proper temperature and for the desired period of time, to any melting point desired. In other instances, steam together with air, is used but the use of steam has its disadvantages which will be discussed later.

The oxidizing effect is so great on the residuum that after it has once been stated by aid of heat under the oxidizer, external heating becomes unnecessary. The reaction then becomes endothermic, due to the chemical changes induced by the introduction of air. The oxidation progresses rapidly at first, and then slows up considerably as it approaches the end of the treatment. Comparatively little is known regarding the exact chemical reactions which take place on blowing with air. However, analysis shows that some of the oxygen actually unites with the asphalt. Another important effect which is well established is that the oxygen eliminates hydrogen by uniting with it (at that temperature—575-600 degrees F.) to form water. In both polymerization and condensation, the hydrocarbons form compounds of higher molecular weight and more complex structure. Blown asphalts vary in consistency from semi-liquids to moderately hard solids at atmospheric temperature.

Advantages of Oxidizing Without Steam

Residuums which have been blown with air without the use of any steam are less susceptible to temperature changes than steam distilled products. In addition they acquire a certain amount of elasticity and resilience. On comparing respective asphalts of the same fusing point and also derived from the same crude oil, the blown product is found to be less brittle, softer in consistency, tougher, and having a lower susceptibility factor than the steamed distilled product. Again the yield of asphaltic residue from the blowing process is considerably greater than when steam distilled. In actual practice, with a topped asphaltic crude, the yield of blown asphalt varies between 75-90 per cent., and of the balance 20 to 8 per cent., is recovered as distillate, with a loss of five-two per cent.

In many cases it is possible by blowing to obtain a residue of better quality than if the steam distillation process were used, and in fact the blowing process renders many crude petroleums available which could not otherwise be used for the production of high fusing point asphalts. It is true that the more asphaltic the crude is, the better the quality of the blown product. Non-asphaltic petroleum crudes in many instances will produce reasonably good asphalts when blown, whereas the same crude will produce worthless residual asphalts by the steam distillation process. Petroleum crudes of a mixed-base character require a very much longer time blowing than the pure asphaltic-base crudes.

Another point which comes into play regarding blown asphalts is this—that it is very much easier to control the grade of product being oxidized. As stated above, the process of blowing or oxidizing, is more rapid at the beginning of the run than towards the end. In other words it might be said that the residual asphalt is said to "come to grade" very slowly. This holds for blown asphalts and where steam distillation is carried out, the alteration is much more marked at the end of the process. The care with which the blown asphalts are prepared largely influences their physical characteristics. If care is not exercised when oxidizing a mixed-base crude the final product will be likely to present a greasy surface, and especially on standing a few days, due to the partial separation of paraffine-like bodies.

One disadvantage, however, of blown asphalts is the fact that they lack ductility. This is particularly true the higher the fusing-point of the asphalt. This defect may be minimized by carefully regulating the process, especially if the asphalt is subjected to a moderate amount of oxidizing. It is a well established fact that the longer the blowing is continued, the less ductile will be the asphalt. If, on account of carelessness or some other uncontrollable reason, an asphalt is blown at too high a temperature or too long it will show a decided separation of non-mineral matter insoluble in CS_2, and a large per-

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centage of carbenes. The former may readily be detected under a microscope. When the blown asphalts first appeared on the market, they unfortunately did not enjoy a good repute, on account of their quality but this has since been greatly improved to such an extent that blown asphalts may now be procured of almost any fusing-point up to 400 degrees F.

These are not only more resistant to temperture changes, but are at the same time as ductile as any unblown product of the same grade. Since specific gravity is an important factor regarding the finished product the question may well be asked, "What is the effect of oxidation upon the gravity of the resulting asphalts?" In the majority of cases, it was observed that the effect of blowing was to decrease the specific gravity of the product. Upon comparing a residual asphalt with a blown product of the same fusing-point, it will be found that the latter is considerably softer, as evidenced by its consistency or penetration. Upon comparing a residual asphalt with a blown product of the same hardness or penetration, the fusing-point of the latter will be considerably higher.

Blown asphalts too, are more soluble in 88 degree Be. naphtha than unblown residual asphalts of the same fusing-points. The blown asphalts are better weather-resisting than residual asphalts made from the same crude. They are far superior to asphalts obtained from acid sludge regardless of their hardness or fusing-point.

Sulphurized Asphalts

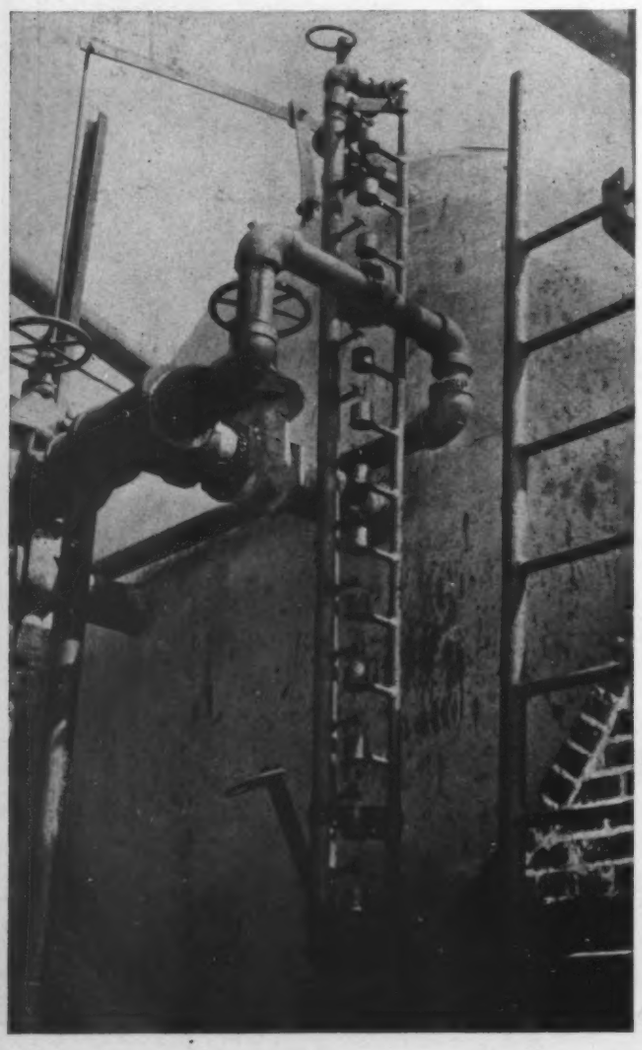
Sulphur has the same condensing effect as oxygen under the action of heat. Sulphur, like oxygen, eliminates hydrogen, except in the form of hydrogen sulphide gas instead of water. The chemical reaction may be represented by the following equation:

$$C_nH_{2n} + S = C_nH_{2n-2} + H_2S$$
Solid gas

The crudes used for this work were Pennsylvania and Ohio. The sulphur was added to approximately 25 per cent. of the residuum at a temperature below the boiling point of sulphur, and the mass heated until the evolution of gas ceased. The resulting product was similar to the blown asphalt in its physical properties, being only slightly susceptible to temperature changes, but still lacking in ductility. On account of the lower cost of production of the blown asphalts these soon displaced the sulphurized products.

Tell-Tale Reduces Fire Hazard

THE black oil spot behind the still battery is not only offensive in its appearance, but constitutes a real fire hazard. Oil soaked earth at the rear of still has been known to flash, and again, it adds to the fury of the still fire when flashes occur due to other causes. The oil accumulates from small leaks in hot transfer lines, unless repaired promptly, and often the stillman in inspecting the battery for liquid level, permits the waste oil to blow onto the ground, and the result is a fire hazard.



Many devices are used to reduce and to eliminate this hazard. Some operators are willing to spend more money than others toward the reduction of the danger. And some are content to use gauge glasses—which are hazards in themselves unless equipped with automatic shut-off or check valves that function as intended.

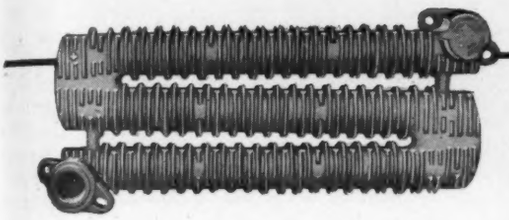
The accompanying illustrations show a commendable "tell-tale" device, which, though probably more expensive in its fabrication than some types, is conducive to cleanliness and elimination of the fire hazard. This type of tell-tale has been in service for several years on the battery of still of the Cushing Refining & Gasoline Company, at Cushing, Oklahoma, and the total absence of oil spots on the ground back of the stills is conclusive evidence of the efficacy of the device.

Two two-inch lines, one at the top and one at the bottom of the shell still, lead into a main header line of the same size. Small nipples are welded into the header line at regular intervals, and into the nipples are screwed sturdily constructed pet cocks. Two two-inch lines leading into the still from the header are both provided with asbestos-packed hot oil stop cocks with long handled wrenches permanently attached for opening and closing. These valves are of value when any one of the small lines or pets become plugged or dirty, for the entire "tell-tale" can be instantly cut off from the still, drained, and the plugged line cleaned out.

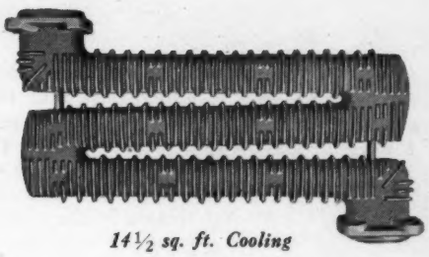
The pet cocks are inspected frequently, and the cores kept tight to prevent leaking. However, in the event of leaks, the drippings will fall into the drain cups, as shown in the picture. The small line supporting the 13 drain cups is open at the top. It conducts the oil removed from the still in liquid level inspection, away from the still through the sewer line and to the trap, where is is recovered.

The receiving devices were made by the plant welder in his spare time, and were assembled from old scrap material—nipples, and collars, (for cups), found about the plant yard. The ladder shown is also a product of the welder's shop, and is provided so that stillmen can reach the pet-cocks with greater ease.

STERLING OIL SECTIONS

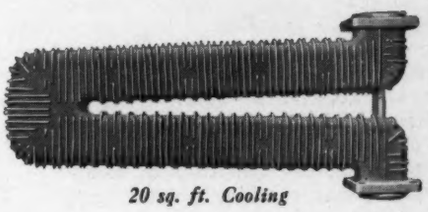


14 sq. ft. Condensing



14½ sq. ft. Cooling

Signify



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Yield of Unsaturated Hydrocarbons in Pressure Distillate Cuts

WITH the increasing demand during the past two years for motor gasoline high in anti-knock value, the average refiner has become interested in refinery processing operations whereby as large a yield as possible of unsaturated hydrocarbons will be present in the gasoline as marketed. Sevearl years ago the presence in gasoline of large amounts of unsaturated hydrocarbons were considered as being detrimental to the quality of the product, but more recently it has been learned that instead, hydrocarbons of the unsaturated series rank high in anti-knock value. Consequently, every possible effort is now made by the refiner to retain in the finished gasoline the largest possible percentage of those hydrocarbons.

Several methods are possible for accomplishing the desired result, among which are to be noted the following:

1. Use of a crude which when "cracked" yields gasoline of high anti-knock value. Illustrations of this are the gasolines of relatively high anti-knock characteristics obtained from Smackover and nearly all California crude oils.

2. Increasing the efficiency of existing liquid phase cracking plants: first, carrying out such plant experimental work as is necessary in order to learn the best temperature and pressure to be employed, for a particular charging stock, in order to obtain the greatest possible yield of unsaturated hydrocarbons in the cracked oil.

3. Use of vapor-phase cracking plants, a matter that is now receiving marked attention from all refiners (primarily because of the relatively high anti-knock value of the gasoline resulting from such processes) and which process has already been so successfully developed and improved upon by the Sinclair Refining Company that the company now has cracking units of the vapor phase type in operation at its Houston refinery.

4. Development of processes of chemical treatment so that the harmful ingredients present in cracked gasoline are removed, but at the same time so that as large a portion as possible of desirable unsaturated hydrocarbons yet remain in the gasoline even after the chemical treatment.

5. Blending together, to make a finished gasoline, natural gasoline and such other refinery "cuts" as will produce under the circumstances a gasoline of the highest possible anti-knock value.

Laboratory Tests

The present article relates mainly to the results of laboratory experimental work conducted with the primary object of noting in which particular "cuts" (resulting from the distillation of pressure distillate) were present the largest percentage yield of unsaturated hydrocarbons—interest in this particular group of hydrocarbons, as before mentioned, being due to the fact that such compounds possess a relatively high anti-knock value.

Laboratory Hempel distillation tests were made on both treated and untreated pressure distillate from the Dubbs cracking process and the yield, color and per cent of unsaturated hydrocarbons thereupon noted on the various fractions resulting from the distillation. The regular, government-approved method for determining the per cent of unsaturated hydrocarbons (acid method), as given in Technical Paper 323-A, was followed in making these tests.

The first distillation on the untreated (Dubbs) pressure distillate was made to note the comparative amount of unsaturated hydrocarbons present in the overhead gasoline "cut" and the residual (gas oil) bottoms. The results of this test are shown below (Table 1):

The next distillation was also made on raw pressure distillate, using fire alone as a source of heat, in order to note (under these conditions) at what particular oil and vapor temperature the overhead distillate (gasoline) went "off-color", as well as to ascertain the per cent of unsaturated hydrocarbons in the different cuts. The results of this distillation test are shown in Table 2, below:

Raw Distillate

In order to see if it would be possible to take off a larger percentage of distil-

TABLE I.

Hempel Fire and Steam Distillation of Raw Pressure Distillate

Amount of raw pressure distillate charged to 2-liter flask fitted with Hempel column, 1600 cc.

Gravity of raw pressure distillate, 47.6.

Distillation test:

	Vapor Temperature °F.
First drop	85
10	166
20	236
30	274
40	346
50	380
60	410
65	414

35 per cent bottoms and loss.

Per cent of *unsaturated hydrocarbons* in gasoline cut (65% overhea).....15.0

Per cent of *unsaturated hydrocarbons* in gas oil (bottoms) 8.5

Remarks. Although the gasoline cut showed a greater percentage of oil absorbed than the gas oil, it is to be noted that, in the case of the former, the acid layer was red and transparent while the latter was very dark and not transparent. This fact shows the tendency of asphaltic and bituminous bodies, as well as other substances that give color to oil—all of which are readily "taken-up" by sulphuric acid—to concentrate in the residual (gas oil) bottoms.

TABLE 2

Hempel Fire Distillation of Raw Pressure Distillate

Amount of raw pressure distillate charged to 2-liter flask fitted with Hempel Column ..... 1600 cc.

Gravity of raw pressure distillate 47.8

Per cent of *unsaturated hydrocarbons* in raw pressure distillate..... 12.0

Per Cent Overhead	Vapor Temperature	Oil Temperature	Color of Composite Sample	Per Cent unsaturated Hydrocarbons in Different Cuts
1st drop	84	134	..	.....
5	114	204	..	22 (First 5% cut)
10	174	264	30+	23 (5-10% cut)
15	206	296	30	25 (10-15% cut)
20	224	310	25+	22 (15-20% cut)
22.5	235	329	25	.....
25	244	342	24+	.....
27.5	270	357	24	.....
30	280	367	23+	.....
40	346	...	....	.....
50	380	...	....	.....
60	410	...	....	.....
65	414	...	....	.....

Per cent of *unsaturated hydrocarbons* in "0-20%" cut..... 23.0

Per cent of *unsaturated hydrocarbons* in "22.5--65%" cut..... 12.0

Per cent of *unsaturated hydrocarbons* in total gasoline cut (65% overhead fraction) 15.0

Per cent *unsaturated hydrocarbons* in gas oil bottoms..... 8.5

Remarks. During the above distillation there was no marked change in the color of the overhead distillate until after the first 20 per cent. had been distilled off. Especial attention is also called to the relatively high percentage (23 per cent.) of unsaturated hydrocarbons in this first 20 per cent. overhead cut.

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For the small tubes in double-pipe ammonia condensers and in marine boilers, evaporator and superheater tubes, etc., measuring $1\frac{1}{4}$ in. to $1\frac{1}{2}$ in. I. D., Liberty Cleaners in the type illustrated at the right are very successful. They obtain maximum power within their size limitation. The single arm cutter head is very effective in small tubes, but it is only one of several which can be furnished with these small cleaners, depending upon the conditions under which the cleaner is to work.

Other Liberty Cleaner types to suit all conditions

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late at a lower temperature without loss in color, the next test was made on raw pressure distillate using steam alone to take off an overhead distillate. The results of this test are shown in Table 3 (below):

TABLE 3

Hempel Steam Distillation of Raw Pressure Distillate

Amount of raw pressure distillate charged to 2-liter ballon flask fitted with Hempel column ..... 1600 cc
Gravity of raw pressure distillate..... 48.0

Distillation test:

Per Cent Overhead	Vapor Temp. °F.	Oil Temp. °F.	Color of Composite Sample
1st drop	92	...	....
5	143	...	....
10	162	190	....
15	180	195	25+
20	190	198	24+

Remarks. The overhead distillate went "off color" shortly after 15 per cent. gasoline had been distilled off, due to the mechanical carrying over of heavy ends as a result of the large amount of open steam required. Two hundred cc. of water condensed in the flask during the distillation, while the last cut taken off overhead ("15-20%" fraction) also contained 200 cc. of water.

Fire and Steam

The next distillation test was made with fire and steam, using only enough direct fire heat to prevent the condensation of the steam in the flask but, however, using enough fire so that the temperature of the whole was gradually increased and thus a uniform rate of distillation was maintained. Table 4 shows the results obtained on this test.

TABLE 4

Hempel Fire and Steam Distillation of Raw Pressure Distillate

Amount of raw pressure distillate charged to 2-liter balloon flask witted with Hempel Column ..... 1600 cc.
Gravity of raw pressure distillate... 48.0

Per Cent Overhead	Vapor Temp. °F.	Oil Temp. °F.	Color of Composite Sample
1st drop	93	120	....
5	130	228	....
10	155	242	30+
15	205	290	30+
20	209	297	30
22.5	222	314	25+
25	226	325	24+
27.5	240	345	23+

Tests on "0-22.5%" fraction:
Color ..... 25+
Gravity A. P. I. 71.0
Per cent of *unsaturated hydrocarbons* 21.6

Distillation test:

Distillation Test

Per cent off	Temp. Off
First Drop	117
10	137
20	153
30	164
40	176
50	188
60	200
70	213
80	228
90	254
92	263
95	281
97	318
End Point	318
Per cent off at 221° F.	76.0
Per cent off at 284° F.	95.5

Remarks. The "0-22.5" fraction from this distillation seemed to be of as good a color as the "0-20%" cut from the straight fire distillation, but the per cent. of unsaturated hydrocarbons in this ("0-22.5%") fraction was 1.4 per cent. less.

The oil temperature when 22.5 per cent had been taken off in this distillation was 314 degrees F., as compared to a temperature of 310 degrees F. when 20 per sent had been distilled over a straight fire distillation of the pressure distillate. It would therefore appear that a temperature of about 310-314 degrees F. is the maximum oil temperature attainable without the overhead distillate's going off-color.

With the exception of the test made in which steam alone was used as the source of heat, the difference in yield of gasoline of good color when using a straight fire distillation or a fire and steam distillation is not great. However, on all these distillations the overhead distillate went off-color very rapidly when once it started to go off and it appears that 22.5 per cent is close to the maximum yield of 25 plus color gasoline that can be obtained from this Dubbs raw pressure distillate: to obtain a maximum yield of gasoline of good color, 400-430 degrees F. in end-point, it is necessary to treat the raw pressure distillate with sulphuric acid.

In order to note the effect that treating had on the yield of gasoline of good color and on the per cent of unsaturated hydrocarbons present in the total overhead distillate (Navy specification end-point gasoline), a sample of raw pressure distillate was treated in the laboratory with three pounds per barrel of 66 degree sulphuric acid, neutralized with a solution of caustic soda and the treated oil then distilled by a straight steam distillation, using a Hempel column filled with beads on the flask as in the previous tests. Table 5 shows the results obtained, together with a comparison of the yield of unsaturated hydrocarbons in similar gasoline cuts obtained from both the treated and untreated pressure distillates.

The experimental data comprising the major portion of this article have been presented to indicate some of the results obtained in the laboratory of one refinery interested in working-out processing operations and methods for obtaining the maximum yield of gasoline, having the highest possible anti-knock value, from a given crude or charging stock. While the data presented are by no means revolutionary in nature, it is thought that they will either serve as a basis of comparison with what other refinery laboratories doing similiar work have found or will be suggestive to others of additional laboratory work that might be done whereby there would be developed some interesting and worth-while data concerning the per cent of unsaturated hydrocarbons present in the different cuts obtained by re-running pressure distillate.

TABLE 5

Hempel Steam Distillation of Treated Pressure Distillate

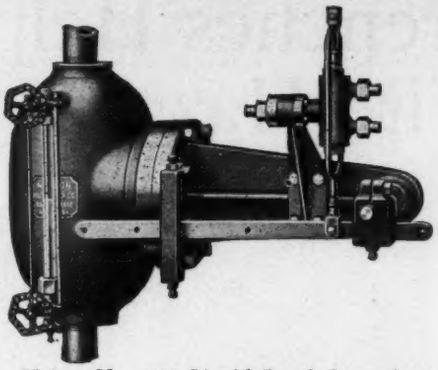
Amount of treated pressure distillate charged to 2-liter flask fitted with Hempel column ..... 1600 cc
Gravity of treated pressure distillate 47.0
Per cent of *unsaturated hydrocarbons* in treated pressure distillate..... 10.0

Per Cent	Vapor Temp.° F.	Oil Temp.° F.	Color of Composite Sample	Per Cent of Unsaturated Hydrocarbons in Untreated Pressure Distillate	Per Cent of Unsaturated Hydrocarbons in Treated Pressure Distillate
5	...	214	30+	...	...
10	...	232	30+	...	...
15	...	248	30+	...	...
20	198	265	30+	...	...
25	215	280	25+	...	...
30	232	300	25+	...	...
35	242	318	25+	...	...
40	258	332	25+	...	...
45	264	346	25—	...	...
50	300	354	20+	...	...
55	342	412	....	...	...
60	364	438	....	...	...
65	382	452	....	12.0 ("0-65%"cut)	15.0 ("0-65%"cut)
34 per cent gas oil bottoms				8.0	8.5

Remarks. Treating this Dubbs pressure distillate with three pounds per barrel of 66 degree sulphuric acid reduced the per cent. of unsaturated hydrocarbons in the pressure distillate from 12.0 to 10.0 per cent. and, upon distillation, the gasoline cut ("0-65%" overhead fraction) was found to have been reduced from 15.0 to 12.0 per cent., while the gas oil bottoms was reduced from 8.5 to 8.0 per cent.

Los Angeles.—The Shell Company has awarded G. Wagner of San Francisco the contract for construction of a three-story laboratory at Emeryville, California.

Laredo, Texas. — The Texas-Mexican Oil & Refining Company of Laredo plans to increase the capacity of its refinery here, and will spend from $150,000 to $250,000 in making the extensions and improvements.



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For accurate control of liquid levels

The pilot valve construction of this Mason Regulator makes it possible to obtain a very fine floating action without having to resort to the use of a differential diaphragm valve for liquid line control.

As a result, single line type of control for liquid levels in stills, accumulators and tanks is obtained, a feature especially desirable when it is necessary to locate the valve at remote points.

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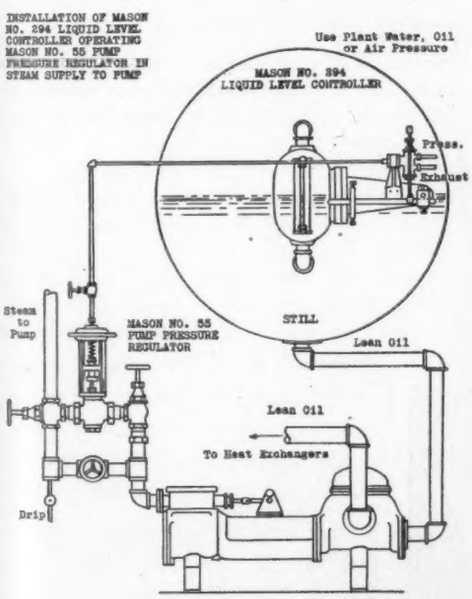
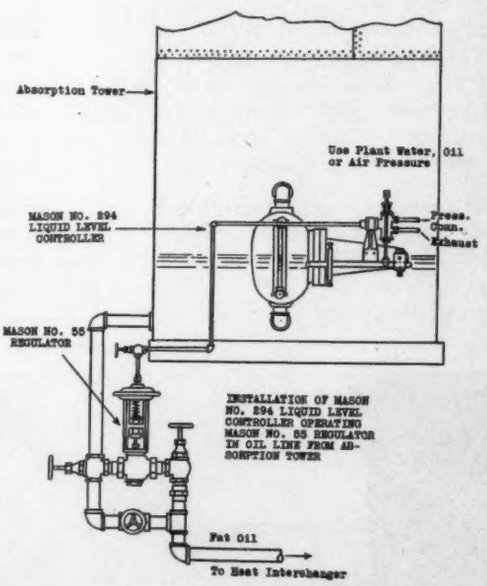
Cast iron for low pressures and temperatures, cast steel with special trim for high pressures and temperatures. Get in touch with our nearest representative or write for descriptive Bulletin.


INSTALLATION OF MASON NO. 294 LIQUID LEVEL CONTROLLER OPERATING MASON NO. 55 PUMP PRESSURE REGULATOR IN STEAM SUPPLY TO PUMP
Use Plant Water, Oil or Air Pressure
MASON NO. 294 LIQUID LEVEL CONTROLLER
Press.
Exhaust
STILL
Steam to Pump
MASON NO. 55 PUMP PRESSURE REGULATOR
Lean Oil
Lean Oil
To Heat Exchangers
Drip

The exclusive features of the Mason Pilot Valve on this equipment insure a steady, non - intermittent flow —this controller can be used equally well with diaphragm valve in liquid line to or from tank or in the steam supply line to the pump filling or draining the tank. See connection diagrams.


Absorption Tower
Use Plant Water, Oil or Air Pressure
MASON NO. 294 LIQUID LEVEL CONTROLLER
Press.
Comn.
Exhaust
MASON NO. 55 REGULATOR
INSTALLATION OF MASON NO. 294 LIQUID LEVEL CONTROLLER OPERATING MASON NO. 55 REGULATOR IN OIL LINE FROM ABSORPTION TOWER
Fat Oil
To Heat Interchanger

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Safety Wrenches Help Control Fire Hazard

THAT zone just behind the still battery and immediately around the heat exchanger equipment is probably the most hazardous from the standpoint of fires, in the refinery yard. Plant operators make special devices for the reduction of this hazard and for the handling of such flashes as occasionally occur.

At the Cushing, Oklahoma, plant of the Cushing Refining & Gasoline Company some interesting methods are in force tending to control of the fire hazard in this danger zone. In addition to the construction of the usual fire walls of brick surrounding the rear of the still battery and the exchanger unit, inside of which any oil spilled during a flash may burn more or less harmlessly until the flame is extinguished, J. H. Hutchinson, general superintendent, and F. A. Davis, superintendent of plant operations, have installed devices which contribute further to the ease of handling any fires which may occur.

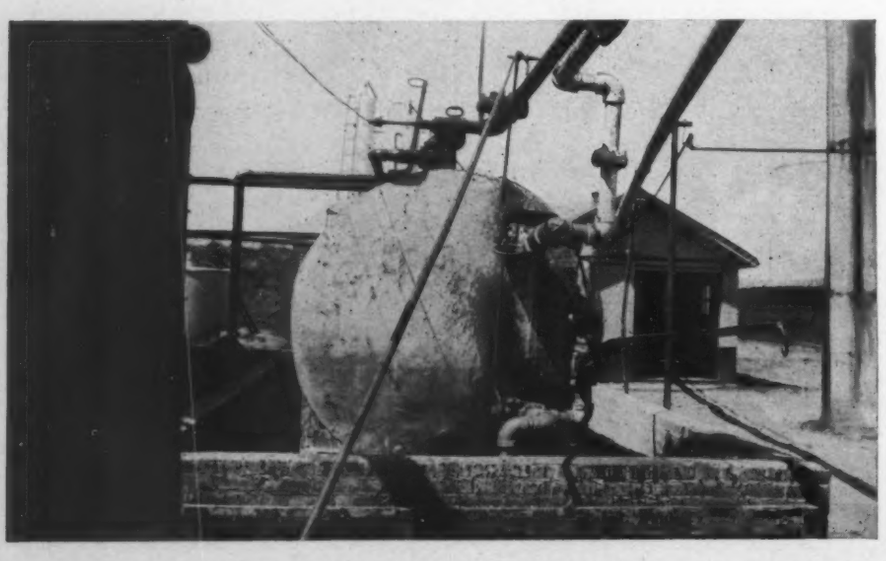
View of rear of still battery showing how all lines are equipped with stop-cocks and individual long handled wrenches.

All of the hot oil lines, still pump-out lines, lines to and from the exchanger, and all "tell-tale" lines are equipped with Fairbanks, asbestos-packed, hot oil stop-cocks. Stop-cocks are positive in their action in the control of flow of oil through this type of valve. Since the opening or closing of stop-cocks requires a wrench—such wrenches are supplied for each and every cock in service. It is this feature which lends further to the safety of the installation.

In the accompanying photographs the type of wrenches used and the method of using them is shown. Photograph No. 1 is a view of the still battery showing the arrangement of hot oil and pump-out lines. Those wrenches extending upward indicate that the lines are open and in service. When wrenches are extending downward the valve is closed and the line not in use. Thus the stillmen can tell at a glance whether or not all of his lines are functioning properly.

The long handles of the wrenches provide sufficient leverage for the manipulation of the stops with ease when operating the stills. The length of the wrench handle varies with the size of the stop-cock upon which it is placed.

These wrenches are all home-made. Most of them were cut by the plant welder in his spare time, from an old still bottom, the rest were made from old sheet steel such as is usually found in the refinery scrap-heap. In such service the wrenches need only be roughly cut. Since each stop is equipped with the necessary wrench permanently, there is no lost time in hunting a wrench to fit a given stop. All through the plant, where stops are used, the welder has provided wrenches, which remain attached to each valve. Like the rising-stem valve, they have the advantage of indicating at a glance the condition of any transfer line.



Lines to and from exchanger equipped with asbestos packed stop-cocks, and individual wrenches. Also showing "hook" used for operating valves as much as 20 feet away.

The second photograph indicates the method of using stop-cocks and long handled wrenches on the lines leading into and away from the heat exchanger. These devices are quick in their action, and require but one pull, upward or downward, to open or close the valves and control the flow of oil.

The valves are made more accessible by means of the long handled hook which is shown in the second photograph. This hook is made of one-inch pipe, provided with a steel hook at one end, and is also a product of the welding shop. Primarily

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it is meant for use in time of fire, and is a means by which a man standing 20 feet away from a given stop-cock, can open or close it without approaching the zone of real danger. It is for this reason that all of the stop-cock wrenches are provided with large steel rings at the end of the wrench. The fire hook, however, is a handy instrument at all times, for with it the stillman can operate all of the overhead stop-cocks without climbing around over hot lines, etc., to reach them.

The installation of this type of control valves and wrenches on the hot oil lines has the advantage of speed when necessary, and also that of accessibility without having to get too close to the valve in time of danger. With the long handled hook, all of the valves are close at hand, even though as much as 20 feet away. The economy of the system is obvious.

In addition to the devices described, the plant operators recognize the value of cleanliness behind the stills and around the exchanger, and in the event of spills or leaks in this area, such oil is immediately removed and fresh gravel and sand spread over the spot. Leaks are prevented or stopped whenever they occur, for it is necessary that no oil soaked spots be permitted in this danger zone, for they may be the source of flashes, or many contribute to fires occuring through some other means.

Rapid Methods for Analysis of Caustic Soda and Soda Ash

BOTH caustic soda and soda ash are used in large quantities by petroleum refiners, mostly in the chemical treating of oils. However, caustic lye is also used in grease-making and soda ash, in water softening. In fact, all refiners use either alkali in one or more processes in their plant.

As an assurance of the purity of the product, is is generally advisable (and especially in all refineries of such size as to be equipped with a chemical laboratory) to make analytical tests as to the purity of the particular alkali purchased. That such an analysis often proves worth while is shown by the fact that one refiner, a few years ago, found a carload of caustic soda (in drums) as received for use in grease-making to contain relatively-large quantities of a gritty substance, similar to finely-divided brick particles, mixed in with the caustic. The shipment was rejected upon the chemist's findings. Had this caustic been used, the gritty materials therein might have caused complaints upon thousands of pounds of grease (since this grit would have had an abrasive effect upon the bearings) with resultant loss to the company.

The methods shown below for analyzing caustic soda and soda ash are procedures that may be followed with the greatest possible speed and yet be consistent with accurate results. In most instances, the total sodium oxide determination will be the only test required, although only a comparatively short time is required for making a complete analysis.

Caustic Soda

Sampling from drum.—When necessary to sample solid caustic soda packed in drums, one, or a certain number of drums, are broken open and a portion chipped from top, middle, and bottom, of which a composite is made.

Analysis.—About 10 grams of the sample is quickly transferred from the container to a tared weighing bottle. After weighing and recording the net weight of sample, it is transferred to a 250 cc. volumetric flask, rinsing the weighing bottle into the flask. The sample is then dissolved in freshly boiled, distilled water, and cooled to tap-water temperature in a cooling box, and allowed to stand until room temperature is attained. The flask is then filled to volume with freshly boiled, cooled distilled water.

Total Sodium Oxide.—50 cc. of the solution is then titrated with normal hydrochloric acid to the end indication of methyl-orange. Burette reading times 3.1, divided by the weight of the aliquot, equals per cent Na_2O. That is, suppose the net weight of sample had been 10.125 grams and the burette reading was 49.7, then

$$\frac{49.7 \times 3.1}{50} \text{ equals 75.08 per cent } Na_2O$$
$$\frac{}{250} \times 10.125$$

Sodium Hydroxide.—50 cc. of the solution is then treated with barium chloride and titrated with normal hydrochloric acid to the end indication of phenolphthalein. The burette reading times 4, divided by the weight of the aliquot, equals per cent. NaOH. Assume that this reading is found to be 49.3, then

$$\frac{49.3 \times 4}{50} \text{ equals 97.38 per cent NaOH}$$
$$\frac{}{250} \times 10.125$$

Sodium Carbonate.—The difference between the methyl-orange and phenolphthalein titrations times 5.30, divided by the aliquot weight, equals per cent of sodium carbonate.

$$\frac{(49.7 \text{ minus } 49.3)\ 5.3}{50} \text{equals 1.04 per cent } Na_2CO_3$$
$$\frac{}{250} \times 10.125$$

Sodium Chloride.—Conventional Volhard method. 50 cc. of the solution is made distinctly acid with nitric acid. Ferric alum indicator is added and about 5 cc. of standard tenth normal silver nitrate is added and titrated with tenth normal potassium thiocyanate to the end indication of ferric thiocyanate. The difference between the two burette readings times 0.585, divided by the weight of the aliquot, equals the percentage of sodium chloride. Example, 1.7 cc.

$$\frac{1.7 \times 0.585}{50} \text{ equals 0.49 per cent NaCl}$$
$$\frac{}{250} \times 10.125$$

Sodium Sulfate.—50 cc. of the solution is made distinctly acid with hydrochloric acid and diluted to 4 times the volume. It is then heated to boiling and 10 per cent barium chloride solution is added drop by drop in sufficient excess. The beaker containing the solution is set aside until the precipitate settles. It is then filtered, dried, and ignited in a tared porcelain crucible. The weight of the barium sul-

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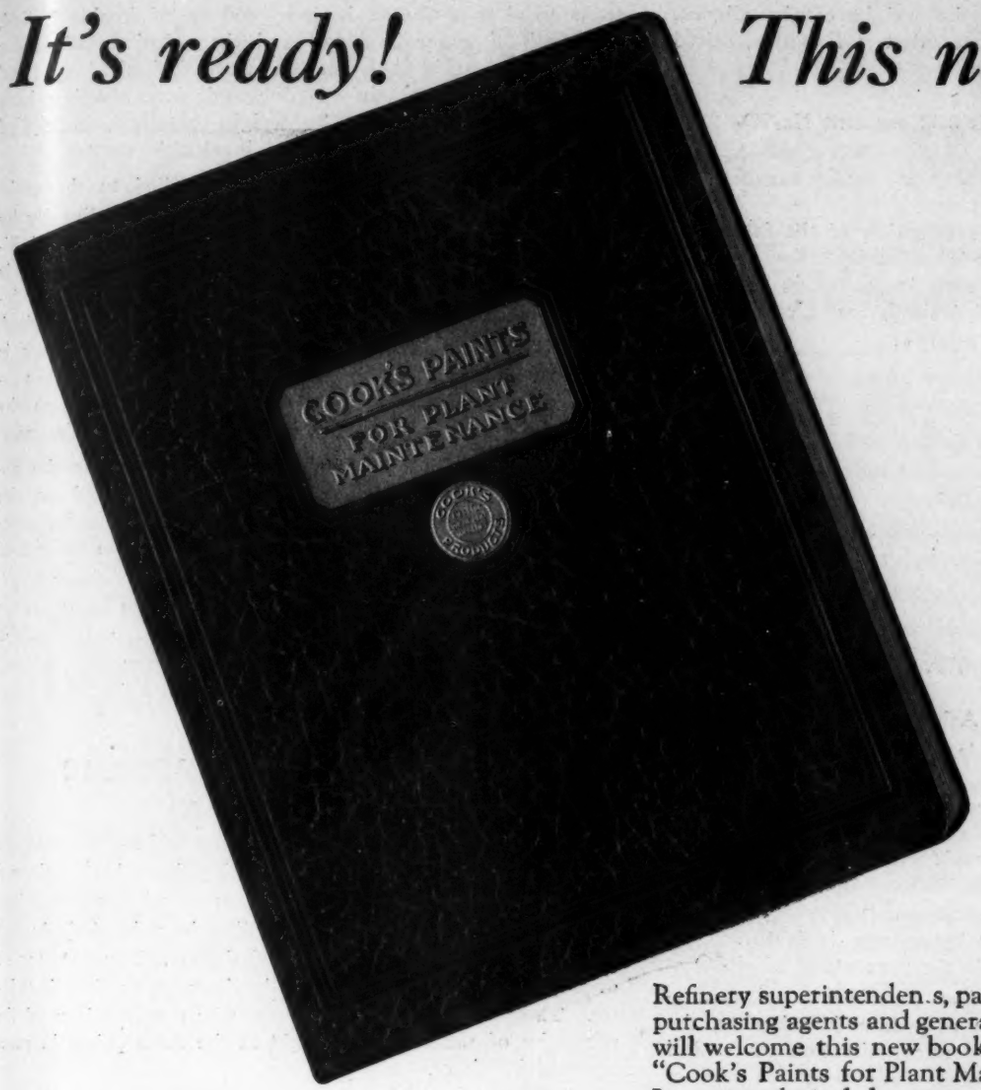

Refinery superintendents, paint foremen, purchasing agents and general executives will welcome this new book by Cook—"Cook's Paints for Plant Maintenance." In non-technical language it describes the paint requirements for every kind of surface in industrial plants: metal, wood, brick, concrete, plaster, stucco. Specific recommendations and specifications are given for every painting problem. Color chips suggest a "standardization chart" for your plant. Copies of this handsome book are distributed on request only, to responsible executives. If you want a copy, write Cook Paint and Varnish Co. Factories in Kansas City, St. Louis, Fort Worth, Houston, Cincinnati. Branches in the Principal Cities, including Tulsa, Oklahoma City, Amarillo, Dallas, Wichita, Denver, Omaha.

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fate times 0.6085, divided by the weight of the aliquot, equals the percentage of sodium sulfate. Example, 0.0105 gram $BaSO_4$.

$$\frac{0.0105 \times 0.6085}{50} \text{ equals 0.32 per cent } Na_2SO_4$$

$$\frac{}{250} \times 10.125$$

The difference between the summation of the foregoing determination and 100 per cent is ordinarily taken as moisture. Since the solid caustic soda is packed in an anhydrous condition, the results, if desired, are calculated and reported on the dry basis, as follows:

Example:

		As Found %	Dry Basis %
Sodium Hydroxide	NaOH	97.38	98.14
Sodium Carbonate	Na_2CO_3	1.04	1.05
Sodium Chloride	NaCl	.49	.49
Sodium Sulfate	Na_2SO_4	.32	.32
Moisture	H_2O	.77	..
		100.00	100.00
Actual Sodium Oxide	Na_2O	76.08	76.67

Soda Ash

Analysis: Total sodium oxide.—Two grams of the sample are weighed on a watch glass and transferred to a 200 cc. beaker to which 100 cc. of freshly boiled, distilled water is carefully added. The solution so obtained is then titrated with normal sulfuric acid. Sulfuric acid is used in order that the conventional Volhard method for chlorides may be done on the same weighed portion. The end point is taken with methyl-orange indicator. The number of cc. times 1.55 equals the percentage of Na2O.

Sodium Carbonate and Sodium Bicarbonate.—If qualitative test indicates the absence of sodium bicarbonate, the number of cc. obtained in the above titration times 2.65 equals the percentage of sodium carbonate. If sodium bicarbonate is present, it is determined by titrating 2 grams of the sample with tenth normal carbonate-free sodium hydroxide solution, using silver nitrate on the spot plate for the indicator. The number of cc. of sodium hydroxide times 0.42 equals the percentage of sodium bicarbonate. The number of cc. in the total Na20 titration minus one-tenth of the number of cc. found in the bicarbonate determination, times 2.65, equals the percentage of sodium carbonate.

Sodium Chloride.—Sodium chloride is determined by titrating the solution after the total Na2O titration, by the Volhard method as described under "Caustic Soda." The number of cubic centimeters of N/10 silver nitrate used, times 0.292 equals the percentage of sodium chloride.

Sodium Sulfate.—Ten grams of the sample is weighed out and transferred to a 300 cc. beaker, to which is added 100 cc. of distilled water. Then hydrochloric acid is cautiously added to a slight excess. The solution is then boiled. To the boiling solution, 10 cc. of a 10 per cent barium chloride is added drop by drop with constant stirring. The solution with precipitate is then placed on a hot plate where the temperature is maintained at just below boiling for 30 minutes. The solution is allowed to cool. When the precipitate has settled, the supernatant liquor is decanted through a filter paper, the precipitate washed by decantation and finally transferred to the filter paper, washed free of chlorides, dried, ignited, and weighed. The weight of barium sulfate obtained, multiplied by 6.085, equals the percentage of sodium sulfate.

Insoluble.—Ten grams of the sample is weighed out and transferred to a 600 cc. beaker. 400 cc. of freshly boiled, hot distilled water is added and the solution boiled for 10 minutes. It is then filtered, washed, ignited at 1000° F., in a tared porcelain crucible and, after cooling in a dessicator, is weighed. The weight obtained, multiplied by 10, equals the percentage of insoluable matter.

Moisture.—Unless special attention is called to the moisture by its being abnormally high, it is taken ordinarily by difference. If direct determination of moisture is indicated, the procedure is as follows: A 1-gram sample is weighed into a 10 cc. porcelain crucible, dried at 102 degrees C. for 1 hour, cooled in a dessicator, and weighed. If no bicarbonate has been found, the percentage loss is taken as moisture. If bicarbonate has been found, the percentage of bicarbonate times 0.369 is subtracted from the loss on drying, and the remainder is taken as moisture.

Density.—Density of Soda Ash is understood as the apparent density of the powder and is expressed as the weight in pounds per cubic foot. It is determined by comparing the weight of a specific volume with the weight of an equal volume of water.

For information as to the above-described methods of analysis for caustic soda and soda ash, acknowledgement is made to The Diamond Alkali Company of Pittsburgh, Pa.

Notes on Drip Gasoline

(*Continued from page* 80)

These mist particles are so small that they will not separate out from the moving gas stream until they have been enlarged either by absorption of lighter fractions or subsequent condensation induced by the passage of the line through relatively cool earth. There is therefore more of the constituent matter of drip gasoline passing the meters in the summer than in winter. These conclusions are borne out by a comparison of the properties of the gasolines caught at the same points in summer and in winter.

Condensation of drip gasoline is, of course, exactly like any other condensation phenomenon in that ti depends solely upon pressure and temperature in relation to the partial pressures of the substances condensed. For this reason it would be very desirable to obtain reliable quantitative and qualitative analyses of both the gas in the lines and the drip gasoline collected under the various temperature and pressure conditions prevailing at the several drips and at different seasons of the year. This has not been done, owing to the high cost of such work, but it is to be hoped that someone will be inspired to undertake thin study who is eqipped to carry it through. The United States Bureau of Mines has done some very interesting work along the lines of ground temperatures at different depths which would make such a study of generally applicable practical value. An abstract of this work

TABLE 3

	Summer		Winter	
	Max. Deg.	Max. Daily Range Deg.	Min. Deg.	Max. Daily Range Deg.
Gas Temp. in 3" Surface Line	139	77	—1	46
Gas Temp. in 6" Line, Buried 1'	83	5	34	2
Ground Temp. 1' deep	83	3	36	2
Ground Temp. 2' deep	79	2	40	2
Ground Temp. 3' deep	77	2	45	2
Ground Temp. 4' deep	75	2	53	2

Note—Data in first two lines determined during a different year from balance of table. Figures by courtesy of U. S. Bureau of Mines.

A Johns-Manville Insulated Tank Top Pays for Itself in Six Months

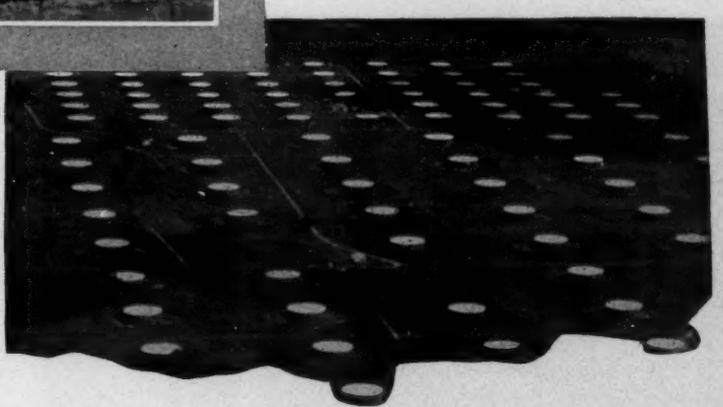
These Vaportight Tops control evaporation loss and save hundreds of barrels of oil

WHEREVER the oil industry has storage problems, remarkable savings are being effected by the use of Johns-Manville Vaportight Insulated Tank Tops. These tops eliminate "wind drift" losses and materially reduce loss due to "breathing." In a recent installation on standard 55,000 barrel wood deck tanks, these Johns-Manville Tops showed proved savings running as high as $5,000 per year per tank. On this basis, the Top pays for itself in six to eight months and the investment represents a clear saving thereafter.

In the West Texas fields where crude has a high sulphur content the resulting corrosion of Steel Tank Tops makes the use of wood decks a necessity. Under these conditions, Johns-Manville Vaportight Tops are especially effective. In addition to reduction of evaporation loss, protection against the effects of lightning is equally important. In over 1,000 installations of Johns-Manville Tops over wood decks where our special grounded conductor network has also been installed, there is not one instance of fires resulting from secondary lightning discharge.

General view of oil tanks equipped with Johns-Manville VAPORTIGHT Tank Top and Grounded Conductor Network.

At right is shown partial view of one of the largest refinery storages in the country. The more than 100 tanks here are equipped with Johns-Manville VAPORTIGHT Tops.



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insofar as it seems pertinent to the other data of this problem is given in Table 3. It will be noted that for all buried lines the daily range in temperature is very small; and that the deeper the line is buried, the smaller becomes the seasonal range. The average hourly temperature of gas in an uncovered line is considerably less than the arithmetical average of the maximum and minimum daily temperatures, but for all covered lines, such an average is very close to the average hourly temperature.

With complete data on line temperatures, with the line pressures known, and with analyses of the gasses passing through the lines, it should be possible to accurately forecast any drip problem that may present itself. While this does not in itself seem to warrant the expenditure of much time or money, complete knowledge along these lines, now so noteably lacking, cannot fail to be advantageous in solving many perplexities of plant operation and gas testing methods.

Screen Keeps Vapors from Fires

DURING sultry weather refineries and natural gasoline plants are subject to aggravated fire hazard due to slowly drifting pockets of gasoline and oil vapors which often find their way into the furnaces of stills and boilers. Refineries equipped with closed type vapor recovery systems are not wholly free from this hazard for small amounts of vapors from leaks will collect and drift slowly about the plant yard. These gas pockets, more frequent at the gasoline plant than at the refinery, forming on dull windless days because insufficient breeze is at hand to dissipate the gas into the atmosphere to the point of dilution where it can not ignite, have been the cause of a great number of disastrous fires with both types of plants.

To reduce this hazard to the minimum the natural gasoline and the refining industries are speedily adopting the use of fine screens which are placed over all openings leading into furnaces about the plant yards. The natural gasoline industry, no doubt because of the greater hazard, was the first to develop and adopt the principle of the Davy's miner's lamp in an effort to reduce, if not eliminate, the number of fires and explosions directly caused by ignition of gas in pockets accumulating from leaks or waste vapors. The Standard Gasoline Company, which is the largest producer of natural gasoline on the West Coast, perfected the system after a series of exhaustive and interesting experiments conducted in its California plants. The results of this work and a description of the manner of application of screens to a number of types of boilers was presented in THE REFINER AND NATURAL GASOLINE MANUFACTURER, page 27, December, 1926, by B. F. Matson of the Standard Gasoline Company, who had charge of the experimental work along these lines.

Since the presentation of the system of screening all openings in all furnaces a great many natural gasoline plants have been so protected and experience has proven the efficacy of the theory in practice. One of the first installations of fire prevention screens in the refining industry is that of The Emery Manufacturing Company at Bradford, Pennsylvania. Many refineries are confronted with the identical problem that existed at the Emery plant, in that lack of space on the plant site, or type of design of refinery, or other contributing factors, bring about a condition where distillation units of power house are too near light oil storage for complete safety. It is estimated that light oil storage should be at least 300 feet from the nearest fire, but explosions attributed to drifting waste vapors have occurred at even greater distances. On warm, sultry nights, vapors may drift in pockets, which are seldom totally separated from each other, to be finally sucked under the nearest still or boiler at relatively long distances from the source of origin. At the Emery plant it was thought that gasoline storage was a little too close to the installation of two tube stills for safety, and knowing that this hazard existed the superintendent and associates developed safety screens which would virtually eliminate this possible source of trouble. Previous publication of types of screens installed for this purpose has dealt only with the screening of boilers and some few fire stills as found operating in natural gasoline plants. The design of screens when applied to the tube or pipe still, is somewhat different. The first experiment consists of the use of flat screens flush with the brick walls of the outside of the furnace, and it was found that difficulty developed in getting sufficient air into the furnace. This condition brought about the change of design as shown in the accompanying photograph. This type of screen increases the area of screening through which air may pass into the furnace a number of times, by presenting five screen exposures, or five sides of a cubical device, instead of one screen flush with the outside wall around the opening. In this manner no trouble develops due to insufficient air in the furnaces.

Safety screens installed.

The screen used is of the 30-mesh brass screen type, closing all aper-

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Complete stocks of every size and pattern of Flanged Steel Fittings according to the American Standard, for pressures of 150, 300, 400 and 600 lbs. in stock at Tulsa. 900 and 1350 lbs. pressure fittings as well as full stocks of cast steel screwed fittings in special oil field patterns are quickly available from factory at Birmingham. In addition, jobbers' stocks at Beaumont and Houston, Texas, provide quick delivery.

With this new and complete service from Tulsa, Stockham Fittings can be supplied for every fitting requirement in the mid-continent fields. No waiting—immediate shipment.

California fields are served with dispatch from Stockham's Los Angeles warehouse. Louisiana fields get immediate shipment from Birmingham.

Descriptive Catalogs on request.

Every Stockham Steel Fitting is hydrostatically tested before shipment. Stockham Steel is free from impurities; never "doctored" in the ladle; no shrinkage; free from sand holes, blow holes, inclusions and cracks. Exceptionally smooth inner and outer surfaces; regular in outline; conformity to patterns; ample fillets well rounded; accurate facings and fine appearance.

STOCKHAM

PIPE & FITTINGS COMPANY

BIRMINGHAM, ALABAMA

Warehouses: BOSTON NEW YORK CHICAGO TULSA, OKLA. (*Steel Fittings only*) LOS ANGELES

Stockham Fittings for the gas, oil field and refinery use are sold by the following oil country supply houses

Oklahoma and Texas

International Supply Company
E. L. Wilson Hardware Company
Midwest Piping & Supply Company

California

The Republic Supply Company
Petroleum Equipment Company

Mention Where You Saw the Advertisement

tures such as air ports in settings, air ports in burners, if present, peep holes and explosion doors.

Another item in the design of these fire preventive screens is that of making them easy to remove either by a close fitting sliding groove arrangement or by using as few bolts as possible. Workmen will take better care of the screens when they may be removed or placed in position easily. This cubical design, presenting five areas through which air may be passed into the furnace is probably the best type of installation to be used in connection with large tube or pipe stills, and large power house units.

The principle involved is one of heat exchange whereby the screen acts to dissipate the heat, and is an application of the Davy's lamp invented in 1815 to prevent explosion in mines. Davy's lamp was essentially an oil lamp surrounded by a cylinder of fine wire gauze instead of the usual chimney. When taken into a mine where there are explosive gases such as methane,—which also is the gas in a large measure responsible for the fires on natural gasoline plant and refinery yards, the gas enters the lamp and burns inside but the flame within does not ignite the gases outside of the screen for the reason that the screen keeps them cooled below their kindling temperature.

The Bureau of Mines experiments have shown that when the velocity of the gas through the screen is over 300 feet per minute, the screen is not a preventive of fire. This velocity, however, would very rarely be reached in plant operation practice.

Method for Correcting Alcohol-Type of Water-Soluble Oil

Many water-soluble oils now made consist of the soda soap of either oleic or rosin acids, *free* oleic or rosin acids (uncombined oleic acid, if a sodium resinate soap is made; uncombined rosin acids, if sodium oleate is the soap), mineral oil, and alcohol and water, the latter two ingredients usually in equal proportions.

The permanence of the emulsion formed when soluble oil is thus made is dependent largely upon the percentage of alcohol and water contained therein. While such soluble oils when properly made give quite satisfactory results in use, refiners and compounders making such products on many occasions find it necessary to correct the oil after it has been made because of its poor emulsification qualities. This condition is due to the evaporation of alcohol from this type of soluble oil, which alcohol may have evaporated in the manufacturer's plant before shipment or in the shop of the purchaser. In most cases it is found that the evaporation has taken place in the customer's shop, due to the oil's having been exposed to excessive heat in storage instead of having been stored in a cool place. Consequently, manufacturers of alcohol-type of water-soluble oils should insist that their customers store such oils until used in cool places.

The method to be described herein is suitable for correcting a water-soluble oil, where its poor emulsification qualities are due to the evaporation of a portion of the alcohol solvent. The procedure is not applicable for correcting mistakes other than that due to loss of solvent.

In making the preliminary tests necessary apparatus includes a 150-cc. measuring graduate and a 1000-cc. Florence flask, which is a flask, round at the bottom and with a long, narrow neck. The use of distilled water also is to be preferred.

One hundred and fifty cubic centimeters of the soluble oil in question is mixed thoroughly with 870 cc. of distilled water and the whole poured into a 1000-cc. Florence flask. This gives a 20-cc. rise above the graduation mark on the flask, thus filling same almost completely. If after standing over night there takes place a separation of any appreciable amount of oil from the emulsion then you can be absolutely certain that the oil needs to be corrected before use; in which case more alcohol or water should be added to a sample of the original soluble oil until the proper amount of solvent is shown by subsequent emulsification tests to be present.

Past experience with alcohol-containing types of water-soluble oils has shown that if a soluble oil when mixed with water turns white the moment the oil touches the water it is in fairly good condition. Furthermore, those soluble oils which pass down through the water as oils and then afterwards turn white almost always fail to form permanent emulsions, but show the separation of oil after standing. Experience also has shown that in making such an emulsification test most of the separation of the oil takes place during the first three hours that the emulsion stands in the Florence flask. Hence an indication is obtained at the end of that time as to the quality of the oil.

In correcting such soluble oils of poor emulsification properties by the addition of either more alcohol or water or both, a common procedure is to make trial experimental blends by adding either alcohol or water or mixtures of the two to the soluble oil in one-tenth (0.1) per cent. proportions until the proper equilibrium is obtained as demonstrated by the stability of the emulsion formed when the above-described test is made. The use of several — or even a half dozen or more — Florence flasks will facilitate the rapidity with which the proper percentage proportion is learned; since thereby numerous experimental mixes can be started at the same time.

From the results of the correction it is necessary to make an order to obtain the most stable emulsion, it is an easy matter to calculate the amount of alcohol or water to be added to the larger quantity of soluble oil. Preferably, this should be done by some suitable mechanical means, since if it is accomplished by air-blowing even more alcohol will be lost, and a further allowance for this loss would have to be made.

The description given herein is not an untried method, for it is a practice followed essentially as given by one of the largest manufacturers in this country of an alcohol-type of water-soluble oil in correcting "off" batches before shipment from the plant, as well as any barrels of soluble oil upon which complaint has been made as to its emulsification qualities.

For the benefit of the reader who desires information as to a quick, simple means of making an emulsification test on any type of soluble oil, below is described the method employed by all departments of the U. S. Government that purchase and use soluble oils, same being given in Bureau of Mines Technical Paper 323 B:

"In a 4-ounce oil-sample bottle or similar vessel place 95 cc. of distilled water and add thereto 5 cc. of the soluble oil to be tested. Agitate vigorously for one minute at room temperature (70 to 90 degrees F.). To be approved for government usage, no separation whatsoever of the oil should occur after standing for one hour."

P.I.W.
STEEL PLATE CONSTRUCTION

FLUID-FUSION
Welded

P. I. W. Fluid-Fusion welded stills should not be confused in any way with the ordinary welded products because Fluid-Fusion welding differs from ordinary welding in the following ways:

It is automatic and eliminates the variable human element.

It is a combination of chemical, mechanical and electrical action.

It excludes such impurities as oxides and nitrides and bonds the parts together so perfectly and intimately that a joint can hardly be said to exist.

It eliminates the so-called "zone of weakness."

It always withstands far greater tension and torsion stress throughout the weld area than the plate itself

To Resist Terrific Heat and Pressure

That is the purpose of Fluid-Fusion welded pressure vessels—to meet the demand which has always existed in the Oil Industry for cracking stills and equipment capable of resisting terrific degrees of heat and pressure.

With Fluid-Fusion welded vessels high pressure cracking is carried to limits unknown before and the Industry is finally rid of the shackles of inadequate equipment.

The automatic-machine welding process developed and used exclusively by P. I. W. in the manufacture of Fluid-Fusion pressure vessels completely removes the wall thickness restrictions set by ordinary manufacturing methods and vessels with 6" thick walls are offered in dimensions up to transportation limits.

Write to the nearest sales office for particulars on Fluid-Fusion welded cracking equipment.

BRANCH PLANT: BEAUMONT, TEXAS

The following products in the order in which they are listed will appear in future advertisements in The REFINER & NATURAL GASOLINE MANUFACTURER. This is a standard list.

STILLS—6" THICK WALLS
OIL REFINING EQUIPMENT
PRESSURE VESSELS
VACUUM VESSELS
AGITATORS
CHEMICAL PROCESSING EQUIPMENT
OIL STORAGE TANKS UP TO 120,000 BARRELS CAPACITY
ELEVATED WATER TANKS
PRESSURE PIPE LINES
PENSTOCKS
AUTOCLAVES
KILNS
DRYERS
ANNEALING BOXES
RETORTS
DIGESTERS
SPHERICAL VESSELS
BLAST FURNACE EQUIPMENT
CREOSOTING CYLINDERS
GALVANIZING KETTLES
EXCHANGERS
SMOKESTACKS
PENNSYLVANIA TANK CARS
STEEL BARRELS AND DRUMS
GENERAL STEEL PLATE CONSTRUCTION

THE
PETROLEUM IRON WORKS COMPANY

NEW YORK
CHICAGO
SHARON, PA.
HOUSTON
TULSA

Refinery and Gasoline Plant Activities

New Plants - Construction Notes - Personnel Changes

GULF NEW YORK PLANT

New York. — Gulf Refining Company is having preliminary plans prepared for a new refinery, storage, and distribution plant at Mariners Harbor, Staten Island, New York. Facilities will be provided for handling crude oil from seagoing tankers, and the properties will include power house, machine shop, and pumping facilities. It is estimated that the total cost will be $20,000,000.

CUSHING PLANT LEASED

Cushing, Okla.—Sinclair Refining Company's refinery here, which has 4000 barrels daily skimming capacity, has been leased by the Globe Oil & Refining Company of Delaware, and it will be put in operation about August 1 after being shut down for three years. The new company which will operate the plant was recently organized with I. A. O'Shaughnessey of St. Paul as president. Mr. O'Shaughnessey is also president of the Globe Oil & Refining Company of Oklahoma, and recently organized the Northwestern Refining Company, which has leased the 2500-barrel capacity skimming plant of the Tonkawa Petroleum Corporation at Tonkawa, Oklahoma.

ITALO BUYS REFINERY

Los Angeles. — Through exchange of stock, the Italo Petroleum Corporation has acquired the refinery and marketing facilities of the Eureka Refining Company of Los Angeles. The refinery, located in Los Angeles, has skimming capacity of 5000 barrels daily, and the marketing properties include 40 retail stations in and around Los Angeles; and 200 independent dealers handle the products. As a result of the merger, the refinery will be enlarged and distribution will be extended to the other. West Coast states. E. L. Pauley, president of the Eureka Company, will become a director of the Italo Corporation.

REFINERY RESUMES

Thermopolis, Wyo.—Operations at the old plant of the Alliance Oil & Refining Company have been resumed by the Mere Oil Company, controlled by E. H. Walden, Chicago publisher. The plant had been closed for the last five years due to litigation. Mr. Walden states that his company will operate with a new process especially designed and adapted to the extraction of gasoline and kerosene from Wyoming black oils.

INSTALLATION COMPLETED

Lawrenceville, Illinois.—The new lubricating plant which the Indian Refining Company is installing in its refinery is nearing completion, and will give the company a larger volume of lubricants. The new plant makes use of the vacuum method of refining lubricating oils.

NEW MEXICO REFINERY

Roswell, N. M.—The 500-barrel skimming plant of the Gilliland Oil Company here has been purchased by Johnson & Lodewick of Roswell and John Champion of Tulsa, and the plant will be in charge of Mr. Champion. Crude will be taken from the Artesia, New Mexico, field, from the Illinois Pipe Line Company.

REBUILD PLANT

Tulsa.—The Rio Grande Oil Company's gasoline plant at Santa Fe Springs is being enlarged and rebuilt by the Jackson Engineering & Equipment Company. The renovation will give the plant a capacity of 30,000 gallons daily. The plant will be in operation about August 1.

TWO SEMINOLE PLANTS

Tulsa.—Sinclair Oil & Gas Company will construct two new gasoline plants in the Seminole area; one in the Little River pool to contain from six to 12 compression units of 350 horsepower each and to be located on the Williams lease, Section 15-7-6; and one in the St. Louis pool on the Blanders lease, Section 24-7-4, to consist of six units of 350 to 400 horsepower.

LUBE REFINERY

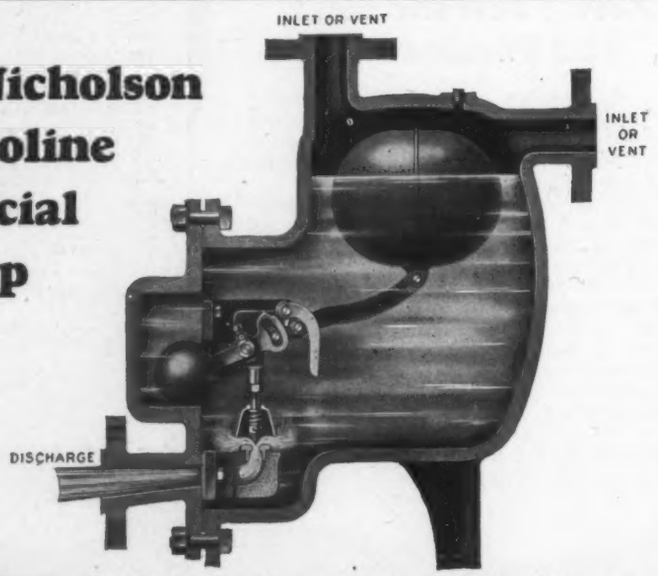
Shreveport, La.—Bayou State Refining Corporation is building a 600-barrel lubricating oil refinery at Hosston, Louisiana. It will operate on crude of pure asphalt base. Officers of the company include G. C. Longman of Chicago, president; S. M. Cook of Shreveport, vice president; and Frank Cook of Shreveport, secretary and treasurer.

Pittsburgh.—George A. Burrell of the Burrell-Mase Engineering Company of this place is spending part of the summer at the Riverside plant of the Universal Oil Products Company, working on cracking problems.

Tulsa.—Independent Oil & Gas Company has awarded contract to the Graver Corporation for construction of a 5000-barrel pipe still at its Okmulgee refinery.

New York.—Prudential Oil Corporation, which operates a refinery at Baltimore, has changed its name to the Prudential Refining Corporation.

The Nicholson Gasoline Special Trap



has been designed especially for handling gasoline—of any density—at any pressure. A few of the distinguishing features that make this trap supreme for gasoline service are—Exceptionally large capacity—A very light float of heat treated steel—Protected valves—Large gasoline seal—Intermittent discharge—etc. Write for bulletin 328 which tells about the above features, and other reasons why Nicholson Gasoline Traps are chosen by the world's largest gasoline producers.

W. H. NICHOLSON and CO.

132 Oregon St., Wilkes-Barre, Pa., U. S. A.

Representatives:

Vinson-Canter Co., 422 Wright Building, Tulsa, Oklahoma

W. H. Nicholson & Company, 1507 Dormont Ave., Dormont, Pittsburgh, Pa.

F. W. Hay & Company, 2732 Cherry St., Kansas City, Mo.

Vinson-Canter Company, 422 Wright Bldg., Tulsa, Okla.

Herbert Wolcott, 207 San Francisco St., El Paso, Texas.

HOMESTEAD

the name of the valves which most successfully handle

HOT OIL

Eight years without replacements and repair is not an uncommon length of service for Homestead Quarter-Turn Valves installed on hot oil and tar lines. Many companies have experimented with various types, grades and makes of valves—only to eventually discover that Homestead valves do the work for the longest time with the most efficient operation.

Made in semi-steel and cast-steel, Homesteads are recommended for pressures up to 400 pounds and temperature to 750 degrees.

All semi-steel straight-way flanged valve

Suitable for handling hot tar or oils at pressures below 250 pounds and temperatures not more than 450 degrees Fahrenheit. Also made in four-way and three-way types.

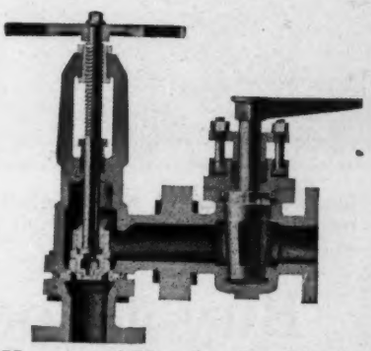
Cast-steel straight-way flanged valve

For hot oil and vapor pressures up to 350 pounds and temperatures up to 750 degrees Fahrenheit.

Made with semi-steel or monel plugs.

At least half of all refineries have Homestead valves in one or more services—and usually the installations were made only after these valves had been proved to be superior to the valves that they replaced. The chief applications of Homesteads in this industry are:

High Pressure Valves;
High Temperature Valves;
Acid Resistant Valves;
Boiler Blow-Off Valves;
Still Valves;
Tar Line Valves;
Gas Drip Valves;
Wax Press Valves;
Receiving Station
Pump House
Manifold Valves;
Gasoline and Kerosene
Line Valves;
Vacuum Service



Homestead Hovalco Combination Blow-Off Valve

Reduce your Boiler Blow-Off expense by using this combination on your boilers. The slow opening angle valve with its renewable seat and disc regulates the blow-off while the Homestead Quarter-Turn is always in reserve.

Made for pressures up to 400 pounds

Iron Body brass plug straight-way valve.

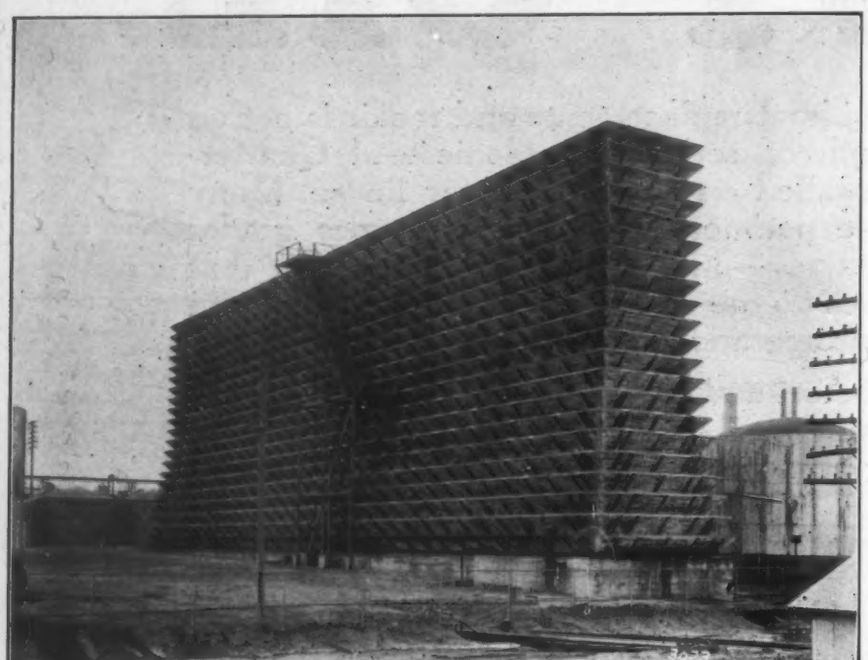
Recommended for handling gasoline and lighter distillates on loading rack service. Also recommended for gas-lift installations.

Homestead Valve Manufacturing Co., Homestead, Pa.

TEXAS-CALIFORNIA CHANGES

Los Angeles. — Following purchase of the California Gasoline Company by The Texas Corporation, three officials of the former company have resigned. J. E. Hare, vice-president and general manager, and E. G. Starr, vice-president and assistant general manager, have opened offices here in the Subway Terminal Building following resignation, and will devote their time to private interests; and H. W. Parmelee, formerly general superintendent of the natural gasoline plants of the California company, is now connected with the Lovell Gasoline Company of Los Angeles. Daily production of the 13 plants which The Texas Corporation bought from the California company is around 165,000 gallons. The output of the company has been around 60,000 gallons daily at the time it was taken over in 1926 by the California Petroleum Company. Messrs. Hare and Starr were among the original organizers of the California Gasoline Company six years ago.

Pittsburgh. — The Burrell-Mase Engineering Company is building a 2000-gallon oil absorption plant near Waynesburg, Pennsylvania, for the George H. Weinrott interests of Philadelphia, and a 1000-gallon per day solvent recovery (gasoline) plant for the Rayestos Company of Bridgeport, Connecticut.



One of our Special Atmospheric Cooling Towers installed at an Oklahoma refinery. This is the largest *single* Atmospheric Cooling Tower in the world, as far as we know.

Buy a Cooling Tower On Which You Can Depend

THE lowest priced cooling tower you can buy is apt to prove the most expensive in the long run. Buy a cooling tower on which you can depend and you have successfully solved your water cooling problems.

In many cases a correctly designed cooling tower or spray pond will return its entire cost during the first year or so. With responsible firms we are ready and willing to enter into an agreement whereby the cost of the tower is spread over a year or more so that the payments can be made out of the savings effected. Our nearest representative will be very glad to explain this plan to you in detail.

THE COOLING TOWER COMPANY, Inc.

15 JOHN STREET NEW YORK

Local Representatives:

Houston, Texas
The J. A. Rossiter Co.,
410 Union Nat'l Bank Building

Tulsa, Okla.,
N. M. Muir,
Kennedy Bldg.

Los Angeles, Calif.
N. O. Fleming Co.,
5815 Maywood Ave.,
Huntington Park

Representatives in Other Principal Cities

COMBINE DEPARTMENTS

Tulsa.—Because of the interlocking of the two departments through the use of gas lift in the production of crude oil, the natural gasoline and the production departments of the Gypsy Oil Company have been combined, with C. P. Dimit as general superintendent. S. G. Sanderson, formerly in charge of the gasoline department, has been made first assistant general superintendent of the combined departments; H. C. Davis is second assistant; R. L. Wright is production engineer; Hollis P. Porter, consulting engineer; and Howard Auerswald, superintendent of gasoline plants.

Tulsa.—Skelly Oil Company has installed a high-pressure fractionating column and other equipment at its Lyman, Oklahoma, gasoline plant, for manufacturing Skelgas and other natural gasoline derivatives. The company has a similarly equipped plant near Borger in the Texas Panhandle.

Los Angeles.—St. Helens Petroleum Company plans to erect a cracking unit at its refinery at Whittier. The plant at present has a daily capacity of 3000 barrels.

El Aguila Petroleum Company of Mexico, a subsidiary of the Royal Dutch Shell, and a major distributor of refinery products in Mexico, plans to double the size of its refinery at Minatitlan, and to increase the pipe line capacity of lines leading to the plant. A total expenditure of 6,000,000 pesos is contemplated.

NATURALINE COMPANY

Tulsa.—The Naturaline Company of America, organized through pooling of development work by Chestnut & Smith Corporation and affiliated companies, Brooks-Hanlon, Inc., Hanlon Gasoline Company, and Smith-Hanlon, Inc., plans to carry on the manufacture and sale of Naturaline, an airplane fuel, in large quantities, and to develop and place on the market other derivatives of natural gasoline. For the purpose of developing such new products, the concern has opened two research laboratories, one at Westwego, Louisiana, and one at Ranger, Texas. Naturaline, which is claimed to be a superior aviation fuel, has been manufactured in one of the Oklahoma plants for more than a year, and its market has been rapidly increasing.

LARGE TUBE STILL

Los Angeles.—Associated Oil Company's new refinery being erected at Watson will make use of an unusually large tube still, only the one to be used in the plant, which will have a crude charging capacity of 15,000 barrels.

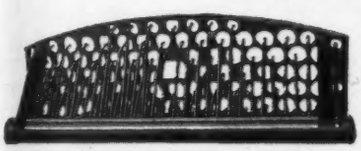
The plant is scheduled to be completed by September 15, and work is now in progress. The output will consist of gasoline, Diesel oil and residium.

E. B. Badger & Sons Company will

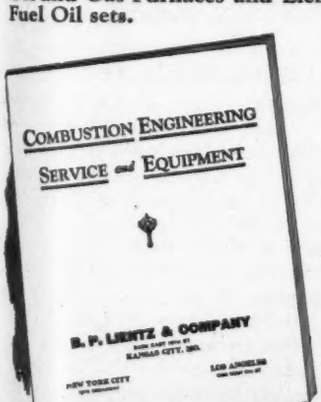
FACTS *Regarding* RECIRCULATION

A CAREFUL INVESTIGATION OF THE LIENTZ RECIRCULATING SYSTEM WILL THOROUGHLY CONVINCE YOU OF ITS OUTSTANDING VALUE!

A HIGH TEMPERATURE FAN OF ADVANCED DESIGN —EFFECTING IMPROVED RECIRCULATION OPERATION



THE LIENTZ GAS BURNER
Applicable to all gas burning requirements. Installed without change in furnace setting. Write for new catalogue showing Lientz Gas and Oil Burners; American Oil and Gas Furnaces and Lientz Fuel Oil sets.



A NEW CATALOG

All bearings outside fan housing. Full water cooled shaft. Eliminates over-hanging wheel. Sturdily constructed of high temperature, noncorrosive metal. All moving parts readily accessible. New peaks in capacities and temperatures of gases handled. Minimum power cost.

"FIRST, WITH THE BEST IN RECIRCULATION"

B. P. Lientz & Company

ENGINEERS & MANUFACTURERS
KANSAS CITY, MO.
Los Angeles New York

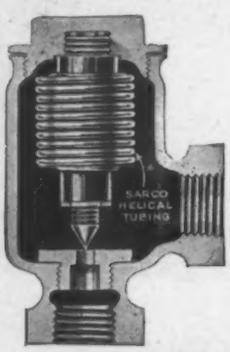
Manufacturers of the Lientz Recirculating System, Lientz Oil Burner, Lientz Gas Burner, American Oil and Gas Furnace and Lientz Fuel Oil Pump Sets.

The LIENTZ RECIRCULATING SYSTEM

This man has saved a million for Steam plants!

This is a silhouette of one of our engineers. He is an expert on trapping steam lines. His job is to save money for manufacturers. Recently he junked the old-fashioned traps in a plant and installed 257 SARCOS. The Sarcos paid for themselves in 7 days and are saving an average of $7,500 per month in coal bills. He has made savings in hundreds of other plants.

If you are interested in saving fuel through the modern trapping of your lines, this man or one of our other engineers, will be glad to examine the trapping conditions in your plant and advise you if SARCO Steam Traps would save money for you. No charge or obligation for this service.



Sarco Steam Trap No. 9 costs only 1/3 price of heavy traps of equal capacity. Sold on 30 days' free trial.

Screws into end of line. No platform, pits or supports needed. Only one moving part. Self-adjusting from 0 to 100 lbs.

Write for Booklet S-284

SARCO CO., Inc.

183 MADISON AVE. NEW YORK CITY

Boston Chicago Detroit Buffalo
Cleveland Philadelphia Pittsburgh St. Louis
Peacock Bros., Ltd., Montreal

SARCO STEAM TRAP

COLOR

YOUR HIGH COMPRESSION

GASOLINE

A DISTINCTIVE COLOR

Write us for samples of colors you wish to try

INTERSTATE COLOR CO., Inc.

41 PARK ROW NEW YORK

install the distillation equipment, including still, bubble tower and all other fractionating equipment. Plans call for a continuous treating system.

Associated Oil Company has a large tank farm at Watson, and consequently very little additional steel storage will have to be built. The company also has a 12,000 barrel topping plant there, and will keep it ready for operation when needed.

L. F. Bayer of San Francisco, vice-president in charge of manufacturing, has general supervision of the erection of the new plant, and H. B. Haney, assistant chief engineer, Los Angeles, will be in charge of the actual work.

BRAUN PLANT IN AUSTRALIA

Brisbane, Australia.—Following the completion of several oil wells near here, making small amounts of high gravity oil and large volumes of gas which is fairly rich in gasoline content, an absorption plant will be installed. The plant selected is a modified Type "D" portable, by C. F. Braun & Company of Alhambra, California.

BERGIUS PROCESS

Although there is no expectation of producing the fuel on a commercial scale in the near future, the Standard Oil Company of New Jersey has acquired the American rights to the Bergius process for the extraction of benzol from coal, and will carry on extensive experimental work in a laboratory at Baton Rouge, Louisiana. Standard will work jointly in the experimentation with the I. G. Farben Industries of Germany. It is not as economical now to produce fuel by this process as to produce gasoline from crude oil, but the process is being worked out in preparation for its ultimate use.

GASOLINE PLANT

Fort Worth, Texas.—Phillips Petroleum Company has obtained five and 10 year contracts for natural gas production in the Church & Fields and Gulf-McElroy areas, and will erect a 50,000,000 cubic foot daily capacity natural gasoline plant immediately at a cost of approximately $1,000,000. Phillips is paying 25 per cent royalty for this gas, and has contracted with some lease owners to begin taking gas January 1, 1929.

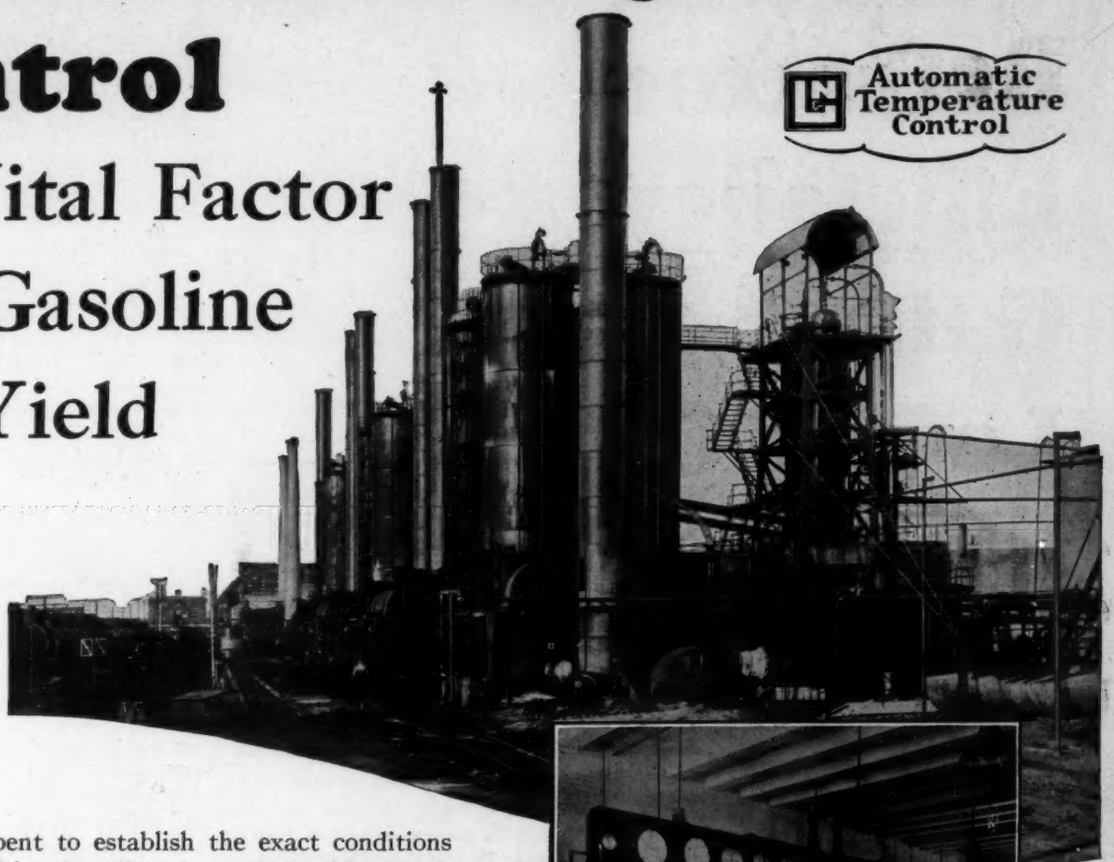
The nearest railroad facilities to the above field is about 30 miles to the south at McCamey, and a line will be constructed to make shipments of gasoline in tank cars to distant markets. A carbon black plant will likely be erected to burn the residue gas. The natural gas in the above field carries in excess of 10 per cent hydrogen sulphide.

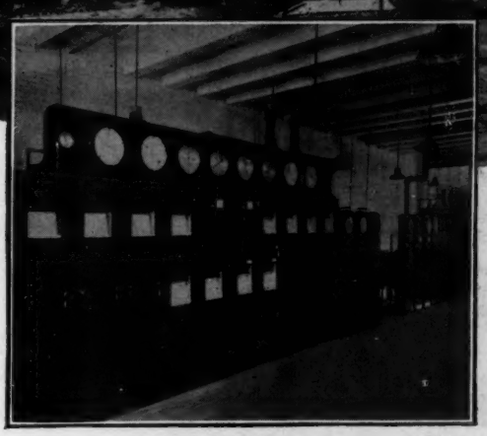
Laredo, Texas. — Cautemoc Refining Company plans construction of a 1500-barrel capacity gasoline and lubricating oil refinery at Nuevo Laredo, Mexico, across the river from here.

Accurate Temperature Control

—a Vital Factor in Gasoline Yield

Automatic Temperature Control





Centralized Control Panelboard. All temperatures of cracking stills kept under observation and recorded in control house.

MILLIONS spent to establish the exact conditions under which each still and tower should operate . . . but losses in yield of gasoline are as much as 5 per cent, just because proper equipment for temperature control is lacking.

Temperature control—if you intend to go after that additional 5 per cent—must be precise and dependable . . . and this calls for the L & N Potentiometer Pyrometer. A pyrometer that is different—a pyrometer that is more accurate—a pyrometer that is more dependable.

Whatever the type of still, it will be a more efficient still if regulated and controlled by L & N Potentiometer Pyrometers. They check waste, steady operations and smooth out the whole course of production.

You should have all the facts in Bulletin 870-R. Write for a copy today.

LEEDS & NORTHRUP COMPANY

ELECTRICAL MEASURING INSTRUMENTS

PHILADELPHIA, PA.

Branch Offices: Cleveland Chicago Houston Los Angeles San Francisco

The L&N *"Different from all others"*

Potentiometer

most accurate • • PYROMETER • • in industry

P-77

Refractory Efficiency Gained at Lower Cost

—that sums up the experience of Southwestern Refineries who use

Texas Fire Brick

Athens Brick & Tile Co., Athens, Texas

Texas Clay Products Co., Malakoff, Texas

Elgin Butler Brick Co., Austin, Texas

Write Any Office for Facts and Figures

Texas Fire Brick Manufacturers Association

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COSDEN BUILDING REFINERY

Fort Worth, Texas.—Cosden & Company has placed contracts for the immediate erection of a complete refinery near Big Springs, Texas, to operate on crude produced and purchased in the Roberts-Chalk field. A 15-mile pipe line, with a gathering system connecting Cosden & Company leases in the field will be built prior to completion of the plant, which is scheduled to be in operation about January 1, 1929, with a maximum capacity of 10,000 barrels daily.

Four Jenkins cracking units, type "5-A," with a daily capacity of 2000 barrels each have been ordered from the Graver Corporation, and two 5000-barrel daily capacity each pipe stills have been purchased from the Foster-Wheeler Corporation. The Jenkins cracking stills are particularly adapted to the handling of the Roberts-Chalk field crude, which averages 29 gravity from the two prolific pay horizons at 2500 and 2900-foot levels, with a sulphur content of about two per cent.

Cosden & Company was organized last February.

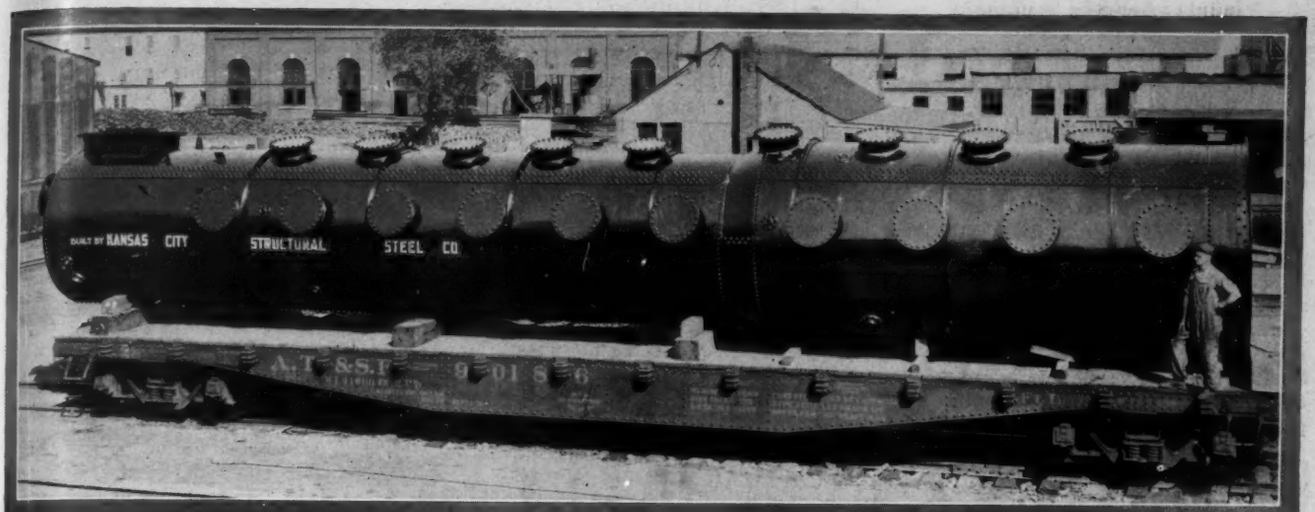
The refinery site acquired by Cosden & Company is located on both sides of the Texas & Pacific Railroad, several miles east of Big Springs, and the plant is to be set up in two separate units, placing two cracking stills and one pipe still in each unit. W. D. Richardson of Tulsa, who has been an active refiner in the Mid-Continent district for a number of years, will be associated with Cosden & Company in the building and operation of one of these units.

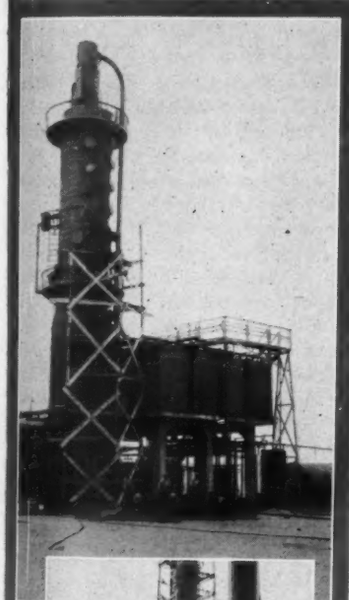
Headquarters of Cosden & Company are located in the Fort Worth National Bank building, Fort Worth.

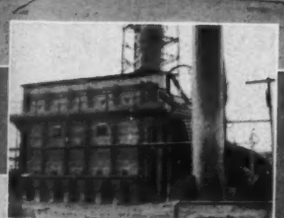
The Big Springs Refining Company was recently organized by R. S. Peterson, Chas. R. Groff and Leon Margules, and is preparing to dismantle a small skimming plant now located at Greenville and rebuild near Big Springs. Arrangements have been made for a crude supply from leases held by Merrick-Bristow et al, Ardmore, Oklahoma, operators, in the Roberts-Chalk area, and the Big Springs Pipe Line Company will gather and deliver the oil to the plant. The latter concern has purchased 15 miles of 4½-inch welded pipe to start construction work immediately. The officers of the Big Springs Pipe Line Company include the following: Joseph Edwards, president; Charles R. Groff, vice-president; L. M. Barker, secretary-treasurer, and C. E. Barker, superintendent.

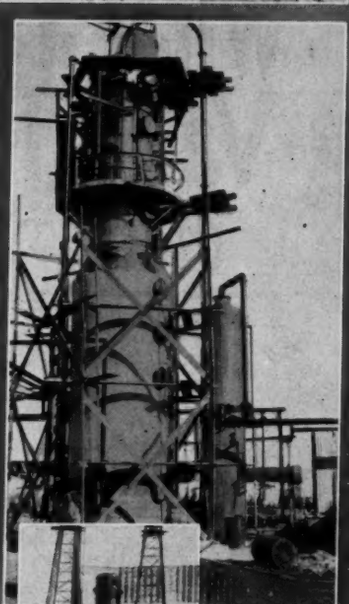
Amarillo, Texas. — Phillips Petroleum Company plans construction of a 20,000-gallon daily capacity gasoline refinery on Rock Creek, Hutchinson County.

Fort Worth, Texas.—Burford Oil Company, Pecos, Texas, has awarded contract for construction of a 5000-barrel capacity refinery to the Graver Corporation.









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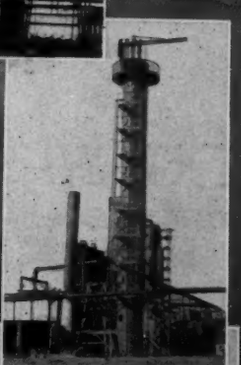
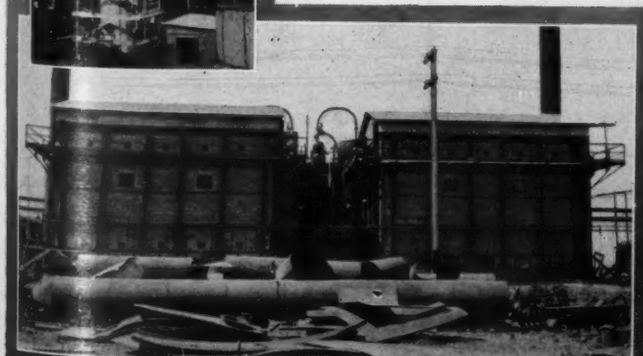




WICHITA FALLS PLANT RESUMES

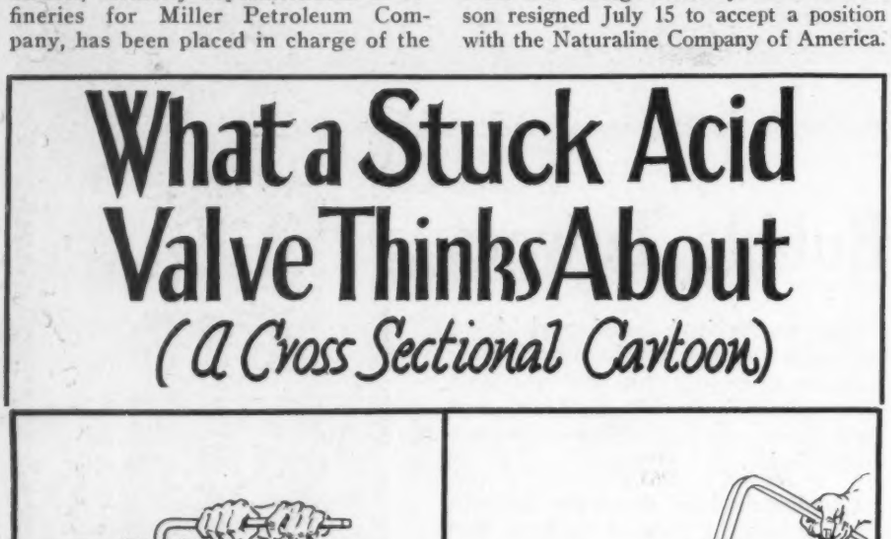
Wichita Falls, Texas.—The J. J. and M. Taxman Refining Company, which acquired the Miller Petroleum Company's refineries at Wichita Falls and at Humboldt, Kansas, last year, replaced the former plant on the active list August 1. The Wichita Falls plant is rated at 2500 barrels daily capacity, and has two Cross cracking units of 1700 barrels capacity. An adequate supply of North Texas crude has been contracted for through the marketing plan of The Texas Company. H. G. Smartt, formerly superintendent of refineries for Miller Petroleum Company, has been placed in charge of the Wichita Falls plant, and J. J. Taxman will be in charge of sales, with headquarters at Kansas City and a branch office at the plant.

Amarillo, Texas.—The Coltexo Corporation is enlarging its gasoline plant at LeFors, Texas, increasing its capacity 15,000 gallons, making the total capacity 35,000 gallons a day.

Tulsa.—Succeeding C. W. Anderson, A. H. Blackall has been placed in charge of the Tulsa offices of the Marland Refining Company, having been transferred from the Chicago territory. Mr. Anderson resigned July 15 to accept a position with the Naturaline Company of America.

What a Stuck Acid Valve Thinks About

(A Cross Sectional Cartoon)



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REFINERY AT CODY, WYO.

Casper, Wyo.—Construction is to be started within the next 30 days by The Texas Company on a new oil refinery at Cody, Wyoming, according to announcements made officially here this week. The plant will have a capacity of 3000 barrels per day, and will be built on a tract of land secured under lease from the government. The refinery will consist of a battery of Holmes-Manley vertical stills, with such incidental equipment as a boiler house, tanks, treating equipment. Orders for all material have been placed and construction will be started this month. The new plant will employ about 50 men. Crude for refining purposes will be obtained from Oregon Basin and other fields now being developed in north and west Wyoming.

MODERNIZE TOLEDO PLANT

Toledo.—The Craig Oil Company, one of Toledo's oldest refining companies, has announced plans to modernize and double the capacity of its plant here at a cost of $1,000,000. Contract for the first pipe still unit has been awarded to the Foster-Wheeler Corporation of New York. The expansion program will include modernization of present stills, new storage tanks and some dock improvements. Through the improvements, the capacity of the plant will be increased from 50,000 barrels monthly to 125,000 barrels.

Tulsa. — Skelly Oil Company will double the capacity of its gasoline plant in the Earlsboro pool in the Seminole field.

Cushing, Okla. — The Cushing Refining & Gasoline Company of this place has had plans prepared for a $50,000 natural gasoline absorption plant at Konowa, Oklahoma, and a $60,000 plant of the same kind at Hazel, Oklahoma.

Bartlesville, Okla.—Cities Service Gas Company will build two new compressor stations and enlarge two others along the route of its 20-inch natural gas pipe line from Tampa, Texas, to Ottawa, Kansas. One 5000 horsepower station is to be erected near Higgins, Texas, and another of the same capacity near Corwin, Kansas. The present stations at Mooreland, Oklahoma, and Tampa, Texas, will be enlarged by the addition of 1000 horsepower each. When all this work is done, the stations will have a total of 27,000 horsepower.

San Antonio.—Golden West Oil Company will build an oil and gas refinery in the Ina field, Medina County. The company will market asphalt taken from the oil.

Long Beach, Calif.—Construction work has been started on the 20,000-gallon natural gasoline absorption plant here on the property of the Bankline Oil Company. J. A. Campbell of Long Beach has the construction contract.

Abstracts of Technical Literature
Of Particular Interest to the Plant Operator

Method of Extracting High-Quality Cylinder Oils from Residue Left from Lubricating Oil. Voronov. (*Neftyanoye Khozyaistvo* 14, 213-16 (1928). *C. A., Vol. 22, No.* 11, *p.* 2051.) Lubricating oil residues were mixed with 15 per cent of heavy gasoline or kerosene and the mixture was treated with 92.5 per cent. sulfuric acid and fuming sulfuric acid (22 per cent. SO_3). The product obtained is then stripped from gasoline or kerosene and treated with fullers earth. The residue was mixed with 15 per cent. kerosene and 0.5 per cent. naphthenic acids. This mixture had a flash point (Brenken) of 100 degrees-110 degrees C.; Engler viscosity at 100 degrees, 3-3.5. Forty kilograms of the mixture was heated with steam to 90 degrees C. and the separated water drawn off; 1 per cent. sulfuric acid (92.5 per cent.) was added, the mixture was agitated with air for 30 minutes and allowed to settle two hours. The acid sludge was drawn off. If water was still left, the drying operation was repeated. Three per cent. of fuming acid was added, the mixture agitated one hour, allowed to settle three hours and the acid sludge drawn off again. A second portion (4 per cent.) of fuming acid was added, the mixture agitated one and one-half hours, allowed to settle three hours, and the acid sludge drawn off again. The residue was given another treatment with 2 per cent. (92.5 per cent.) sulfuric acid, agitated for one and one-half hours and 0.05 per cent. of 20 degree Baume caustic soda solution added. After four hours' settling the sludge was drawn off, 15 per cent. of hot water added to keep the temperature at 90 degrees C. and after three hours the acid water was drawn off. The flash point (Brenken) increased 2 degrees-5 degrees C., Engler viscosity at 20 degrees decreased 3 degrees-4 degrees; the color was dark green. Superheated steam (250 degrees-280 degrees C.) was used to evaporate the sulfur dioxide and sulfur trioxide. After this treatment the yield of oil was 65-66 per cent. of the residue used. The oil obtained had a flsh point (Brenken) of 290 degrees C.; Engler viscosity at 100 degrees, 6.10; coke (Conradson), 3.2 per cent.; color, faint dark green. After treatment with 3 per cent. of fullers earth, a total net yield of 60 per cent of oil resulted.

Treated Residue	American Cylinder Oil	Russian Viskosin 7
Flash (Brenken) 305-310°	280-290°	300° and more
Viscosity E_{100} 6-6.5	5-5.5	7-8
Carbon (Conradson) 2.2-2.4%	4.5-5.5	2.8-3.0
Color	Dark Green	Green Black

The cost of making this oil is equal to that of Viskosin 7. This process is covered by Russian patent 16,151 issued March 26, 1927.

Distillation

Gasoline Stripping Plant. Denievich.—(*Azerbeydj. Neft. Khoz.* 1928, *No.* 1, 59-64. *C. A., Vol.* 22, *No.* 12, *p.* 2262.) A plant is described and very complete drawings are supplied. The slightly preheated crude oil is pumped through a tube still, which is connected to an evaporator; both are heated from the same fire box. The evaporator is placed in the stack and is heated by open fire and flue gases. The gasoline, ligroin (Russian) and part of the light kerosene are evaporated; the oil left is heated in the battery in the customary way. The evaporated fraction consisted of 3.73 per cent. of benzine, 2.32 per cent of ligroin, 4 per cent. of light kerosene. The crude oil contained originally 5.5 per cent. of gasoline. The crude oil had a temperature of 75 degrees C. when it entered this still and 175 degrees C. on leaving. The heat recovery of this equipment is given as about 75 per cent.; fuel consumtpion, 0.7 per cent.

Changes in Construction of Present-Time Stills. Vuisketravsku.—Azerbeydj. Neft. Khoz. 1928. *No.* 3, 58-69. *C. A., Vol.* 22, *No.* 12, *p.* 2263.) Different still equipments used by American oil concerns are described, together with two Russian constructions which have never been made known. The still constructed by Krupoves for the Shibayev Company in Baku is a combination of three stills in cascade form. Each still has a dephlegmator. The preheated gasoline enters the top dephlegmator,—the uncondensed vapors enter the top still; from the top still the evaporated gasoline is led into the second dephlegmator, then second still, etc. The still constructed by Pokrovsku for the A. I. Mantashev Company in Baku is based on the same principle, but in construction details is slightly different.

Tube Still for Distillation of Crude Oil. Ackerman.—(*Neftyanoye Khoz.* 14, 193-212 (1928). *C. A., Vol.* 22, *No.* 12, *p.* 2263). Very complete calculations are given for the construction of tube stills, including whole equipment such as evaporators, condensers, heat exchangers, etc.

Cracking

Cracking Catalysts. Pincass.—(*Petroleum Times, June* 2, 1928, *p.* 1020. *Libr. Bull., U. O. P. Co., Vol.* 3, *No.* 25.) Among aluminum chloride catalysts Swiss Pat. No. 111354 describes a mixture consisting of aluminum chloride, an alkali or alkaline earth, a silicate and a mineral oil high in sulfur and unsaturates. The pitch-like mass has little hygroscopicity. A U. S. Pat. No. 1,525,041 describes the preparation of aluminum chloride by the action of phosgene upon aluminum metal or an aluminum silicate at blast-furnace temperatures. There is some question as to whether $ALCL_3$ is a true catalyst, since large quantities must be used. French Pat. No. 554680, Brit. Pat. No. 204458, Ger. Pat. No. 382090 protect the use of active carbon as an accelerator for cracking. Hydrosilicates, containing more than 5 per cent. of free silicic acid may be used, according to Ger. Pats. No. 378004 and 379895 and Fr. Pat. No. 520322. Ordinary fullers earth and clays are not suitable as catalysts, but Florida and Georgia earths may be used. The stock is cracked in a still with a dome containing a charge of granulated catalyst. The hydro-silicate can be revivified 40 times before discarding by extracting with kerosene and steam. The hydro-silicates hold out the asphaltic compounds, so that the residual oil after removing kerosene and gas oil distillates can be used directly as a lubricating oil without acid treatment. The quantity of this catalyst used varies from 5 to 25 per cent. Many patents have been taken out for the use of rare earth oxides as catalysts, either alone or in combination with nickel or nickel and copper. U. S. Pat. 1,423,709 describes the use of mercury vapor in the presence of hydrogen at 600 degrees, either under pressure or under partial vacuum; the process is said to give a very high yield of gasoline. By the use of active carbon Herbst is said to have obtained from 4 kg. of paraffin at 300 degrees to 450 degrees, without pressure, 27 per cent. of light benzine, 16 per cent. of heavy, and about 26 per cent. of kerosene.

American and German Cracking Problems. Magnus—(*Erdol u. Teer, May* 25, 1928. *Libr. Bull., U. O. P. Co., Vol.* 3, *No.* 24.) In America the middle fractions from crude oil form an abundant and cheap raw material for cracking. In Germany with its limited oil supply the prices of these middle fractions are raised by middlemen's profits, freights, and taxes to such a point that they cannot be used for cracking. For material for that purpose Germany must look to her brown-coal and shale tars. The struggle is the same in both countries to reduce carbon deposition in order to make the cracking process a continuous one, and to limit the unavoidable carbon deposition to the less inconvenient places. There is less formation of free carbon with materials rich in hydrogen than with asphalts and tars, which are comparatively poor in hydrogen. This explains why different types of cracking apparatus have developed in the two countries. The principle is the same in both, however, to provide as large heating surface as possible in order to keep the temperature of the heating surface as near the desired temperature of the oil as possible. Otherwise hot spots occur and carbon and pitch are baked on. The heat loss thus entailed, while unimportant in America, is Germany threatens the rentability of cracking processes; this danger is increased many times over by the character of the raw material available for cracking in Germany. But, what is still more final, cracking in tubes makes it impossible to obtain lubricating oils at the same time. This limits the products to gasoline and fuel oil whereas Germany today produces high-grade lubricants even from Panuco and Venezuela crude. These circumstances have led to the development of processes employing a bath of molten

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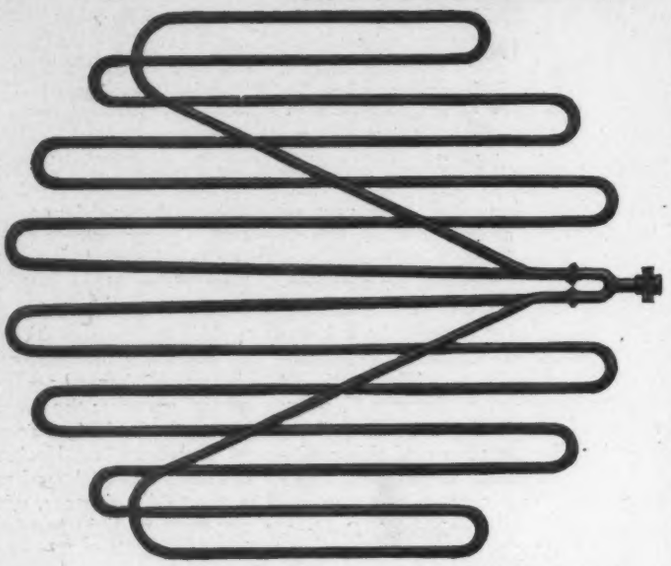

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metal for heating. This idea was an American invention but was not developed there because the metal formed sulfides with the sulfur in the oil, and because the separated carbon combined with the metal particles to form coke and slag particles. But the method is economical of heat and improvements have been worked out which largely overcome the defects. According to Ger. Pat. 340991, 1920, Blumner patentee, devices are built into the bath which prevent contact of the crude with the walls of the reaction chamber heated from the outside. This reduces free-carbon production, and completely prevents its baking on. The surface of contact between metal bath and charging stock constituted another danger zone. This was corrected according to Ger. Pat. 439044, Blumner, by filling the reaction chamber completely full of metal and allowing the cracking to take place in a second well-insulated chamber containing no metal but directly connected with the first. The Blumner process works at 40 atmos.' pressure, which reduces the temperature necessary and prevents the sulfur from uniting with the metal. The Blumner process as now developed is nearly ideal for all charging stocks which crack below 450 degrees C. For cracking stocks containing a high percentage of acid constituents, like certain generator tars, higher temperatures would be required, though pipe stills would be coked up almost immediately. The completeness of American industrial laboratory equipment and thoroughness of routine testing are described.

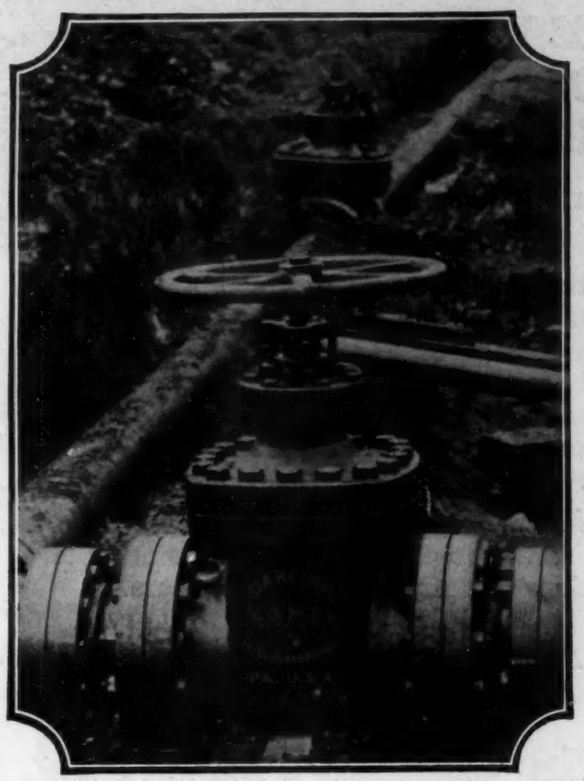
Fractionation

Separation of Fractions and the Size and Shape of Rectification Columns. Kostrin.—(*Neftyanoe Khoz.* 13, 180-7 (1927). *C. A., Vol. 22, No.* 12, *p.* 2263.) Higher columns increase the fuel consumption of stills. By increasing the cross section of the column the fuel consumption is not always increased. Very high columns connected to open-fire stills improve the separation of heavy fractions; those for steam distillation improve the separation of light fractions. A high narrow column works better than a wide low one with the same capacity.

Fractionation. Brandes.—(*Chemische Fabrik, May* 9, *pp.* 261-2.) A simple graphic method is described for ascertaining the efficiency of a fractionating column from the composition of the distillate. The sample graphs are shown and explained.

Treating

Operating a Continuous Plant for Refining Distillates. Morrell and Bergman. (*Chem. and Met. Eng., Vol.* 35, *No.* 6, *pp.* 350-54.) Continuous treating systems consist of a combination of mixing, settling and washing equipment, the particular order depending upon the method of treatment. Each individual step or reagent in the treatment requires a mixing and settling element. Authors describe, with flow sheets, the design and operation of continuous treating plants for treating both gasoline and pressure distillate, including in such description detailed information as to the design of both acid and



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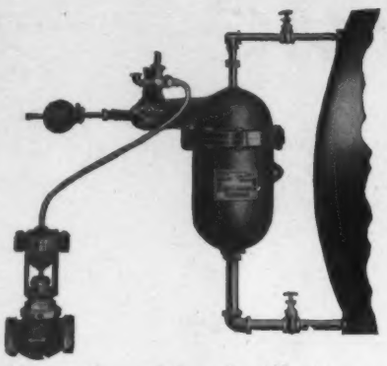

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plumbite or caustic orifice mixing columns, settling tanks ore chambers, and other accessory equipment.

Storage tanks should be provided for the acid, caustic and plumbite solutions. For the last, two tanks should be provided, one for preparing the plumbite solution and the other for recovering the plumbite sludge. These tanks should be equipped with perforated steam-coils and perforated air lines for mixing and for recovering products.

Two mixing tanks for caustic and doctor solutions and the tank for recovering spent doctor may be made five feet square and four feet high. The tank for recovered doctor solution should be placed on the ground, so the solution can gravitate into it from the agitator. The mixing tanks should be set high enough above the ground so that the solutions can be run by gravity into their respective blow cases. An "I" beam trolley and walkway should be built above the solution tanks to facilitate the lifting and handling of drums of caustic soda, and the like. Water and steam lines should be provided for both of these tanks, and either a small pump or an air or steam syphon should be installed for raising the spent plumbite solution to the mixing tank after the sludge has settled out.

The acid storage tank should also be placed high enough so that the acid will run by gravity into the blow case. Ordinarily the acid sludge is not recovered in a small plant, but is run to a sludge-acid pond. If a recovery system is used for acid, an acid-sludge tank may be included. In some refineries, this sludge acid is diluted with water and run to the sewer, but this practice is usually stopped by governmental authorities because of the pollution of streams.

A separating sump should be made of concrete with two or three vertical baffles for separating oil from wash water, sludge and tar discharged from the agitator. This sump should be about four or five feet wide, three or four feet deep, and about 12 or 15 feet long. A small sump should be placed alongside with a swinging suction line, enabling it to skim oil off the top of the sump compartments. This sump should be surrounded with a railing.

In treating pressure distillate, an average of 12 degrees Baume plumbite will be used. This is prepared by making up the caustic to the desired gravity and adding approximately three pounds of litharge per barrel of caustic while the latter is hot and is undergoing agitation. For the split plumbite treatment stronger solutions are used prior to the acid treatment, e.g., 25 degrees Baume gravity, in which case approximately six pounds of litharge per barrel of caustic soda solution is used.

Plumbite sludges may be recovered by blowing the precipitate formed during the treatment with air in the presence of caustic solution. This should be done, preferably, at a temperature of 150 degrees F.

The foundation of the equipment used for this purpose should be high enough to permit channels for the drain pipes and allow replacements. The tanks are skirted and bolted to the foundations.

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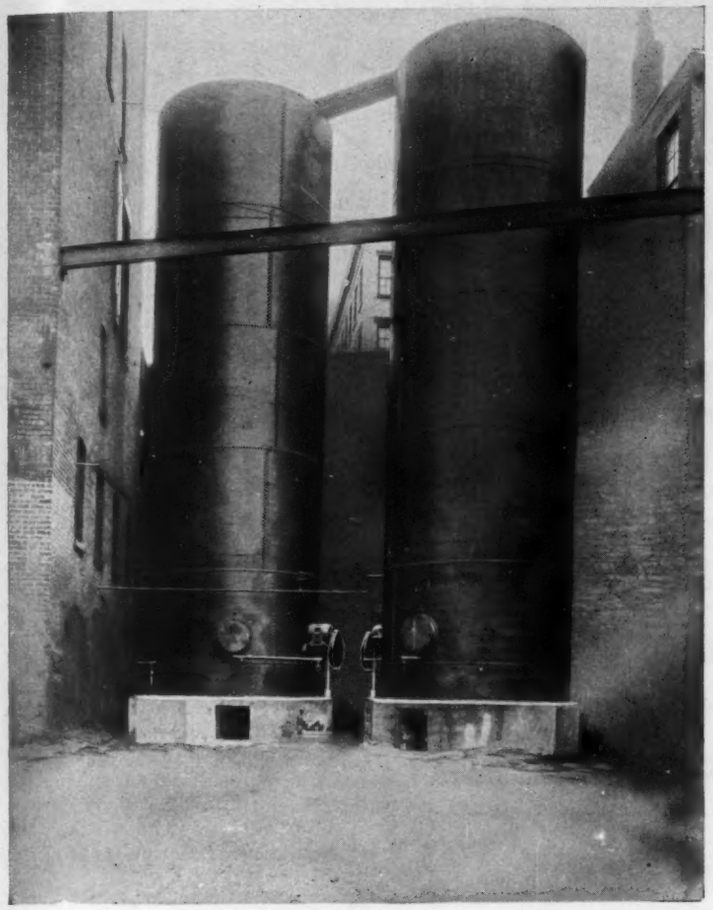

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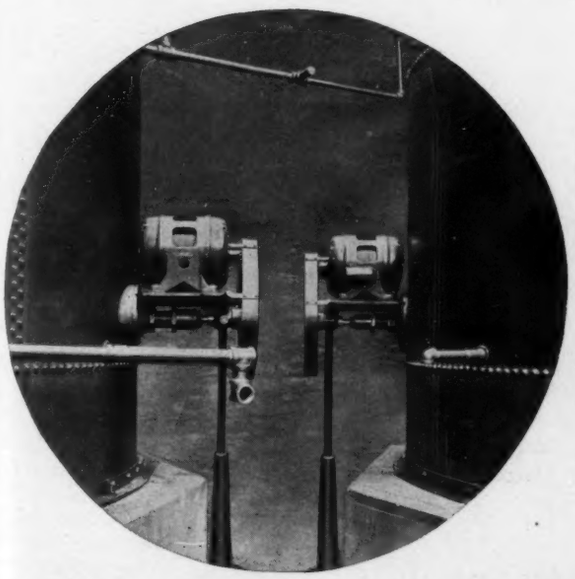

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the reagent and oil in order to modify or control the reaction, heat exchangers or refrigerators may be used preceding the mixing elements.

This is the third and last of a series of three articles by the authors: The original articles can well be studied to advantage by refinery engineers, plant superintendents and treating plant operators—presenting as they do most modern practice in the treatment of light oils and in the design and construction of equipment in which such treatment takes place.

* * *

Recovery of Products from "Spent" Doctor and "Spent" Caustic Solutions. Meehlin. (Petr. Div. A. C. S., St. Louis Meeting, April 1928. *Libr. Bull., U. O. P. Co., Vol.* 3, *No.* 26). The spent caustic and spent doctor had been used in treating pressure distillates from Smackover and Urania crudes. The spent caustic contained caustic soda, sodium sulfate, and dissolved tarry material; gravity, 8 degrees Be.; spent doctor, caustic soda, sodium sulfate, tarry materials of the type ROH, lead as plumbite ion, floating or in suspension, lead sulfide and lead in organic combination; gravity, 23 degrees Be. Evaporation was conducted to 42 degrees and 45 degrees Be., respectively, using eight pounds exhaust steam in a submerged coil of steam pipes for the first part of the heating. The temperature had finally to be carried to 270 degrees. Air heated by waste steam was bubbled through with the idea of oxidizing the lead sulfide to sulfate. Iron equipment was used and, in apparatus of semi-plant size, 80 to 90 per cent of the caustic could be recovered, and up to 84 per cent of the lead.

* * *

Filtration

Bleaching Earths in the Oil Industry. Typke. (Petroleum, June 1, 1928, *p* 673, *Libr. Bull., U. O. P. Co., Vol* 3, *No.* 25). It is a convenient distinction to designate as "raw earths" the bleaching earths in the state in which they are taken from the ground, and as "natural earths" the product in salable condition not chemically treated. The process of disintegrating in use at present is as follows: The raw earth moist from the ground, after washing if necessary to free it from the coarser foreign material, is stirred to a thick sludge with water in big vats, usually of cement. Enough hydrochloric acid is added to give the optimum acid concentration as shown by laboratory tests, or sulfuric acid may be used; and the mass is heated with steam for several hours. It is then filtered on large filter presses and the acid remaining in the filter cakes is washed out in several washings. Drying to low water content and grinding follow and the material is now "activated earth." The increased bleaching power is probably not due to converting the natural silicates to silicic acid hydrates, as has been thought; experiments by Eckart and Wirzmuller showed that silicic-acid hydrates had no bleaching action; and the activated earth was not soluble in soda solution. The heightened bleaching action of the activated

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18% Chromium **8% Nickel**

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The following are typical physical properties, which may vary according to the normalizing temperature and also slightly with the amount of cold work done on cold drawn tubes in drawing to small sizes.

Physical Properties

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Tensile Strength Lbs. per sq. in.	105,900	91,000
Yield Point Lbs. per sq. in.	74,000	35,000
Elongation in 8 in.	28%	35%
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Chemical Analysis

Carbon . . .	Under .12%
Manganese . .	Under .50%
Phosphorous .	Under .03%
Sulphur . . .	Under .03%
Silicon . . .	Under .50%
Chromium . .	17.0-19.0%
Nickel . . .	8.0-9.0%

Still Tubes of Enduro 18-8 will eliminate the frequent costly replacements where tubes of other materials are being used. Complete information will be gladly sent to anyone concerned with still tubes costs, on request.

Castings of Enduro 18-8, made in high frequency induction furnaces, are also manufactured by The Babcock & Wilcox Tube Co.

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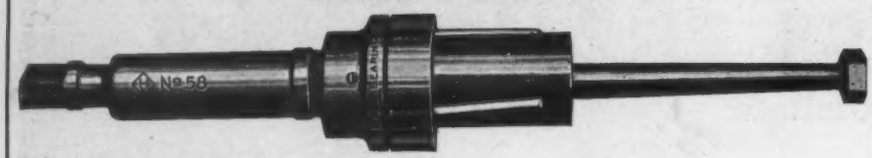

Tools for the Oil Industries

Hydraulic Pressure Pumps, 8000 pounds
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earth is probably due to removal of the weathered material and leaving the unweathered clay exposed. Deckert showed that the chemical constitution of the earth is not materially changed in the activating process and that the physical structure is very strong. Loeb's view is that in the activating process the silicates are hydrated, but free silicic acid is not formed. The action of bleaching earths is one of adsorption, and polymerization and also of oxidation, Wesson claims; all earths are capable of oxidizing Mohr's salt. Chemical analysis shows nothing as to the action of an earth; earths of very different composition have the same activity, and on the other hand those of similar composition differ markedly in their action. The grains are traversed by innumerable canals of microscopic or even ultramicroscopic size and it is upon this structure that the action depends. The finer the earth is ground the better its action, up to a certain degree. Beyond this, filtering becomes very difficult. Certain American earths when ground too fine easily stop up the presses, while English earths under the same conditions give no trouble. An earth of too small penetrability does not permit the filter cakes to be sufficiently pressed. The penetrability and filterability are raised in the activating process. Sharp distinction must be made between volume weight and specific gravity. Volume weight depends upon fineness. Finer grindings of the same earth have a smaller volume weight than coarser. Volume weight is essential in order to determine how much space a certain quantity of earth will occupy and for calculating the number of filtering chambers required. The volume weight is of course always lower than the specific gravity. The latter is always the same for a given earth. The specific gravity of activated Bavarian earths according to Eckart and Wirzmuller is from 1.85-2.00; Florian found 2-2-36. American earth has a specific gravity of 1.85; English is 2.13.

* * *

Filter-House Problems. Lewis. (*Meeting of National Petroleum Association, Cambridge Springs, Pa., April* 19, 1928. *Libr. Bul., U. O. P. Co., Vol.* 3, *No.* 24). The paper presents opinions as to filter-house operation, gathered from eight plants in the Warren section of the N. P. A., upon (a) solution of 600 stock and long residuum, (b) neutrals, (c) 600 stocks straight, and (d) long residuum stocks straight. The fuller's earth is usually purchased from the Floridin or the Attapulgus Clay Company. Testing methods for earths should be developed and applied. The Nichols-Herreshoff furnace is the most efficient of those in common use for revivifying clay, giving 30-40 burns against 6-9 by the other furnaces. The temperatures at which earth should be burned are: First burn on new earth for straight stocks and solution, 700 degrees F. max. Second burn, 900 degrees to 1100 degrees F. Low temperatures and long periods of burning give better filtration and prolong the life of

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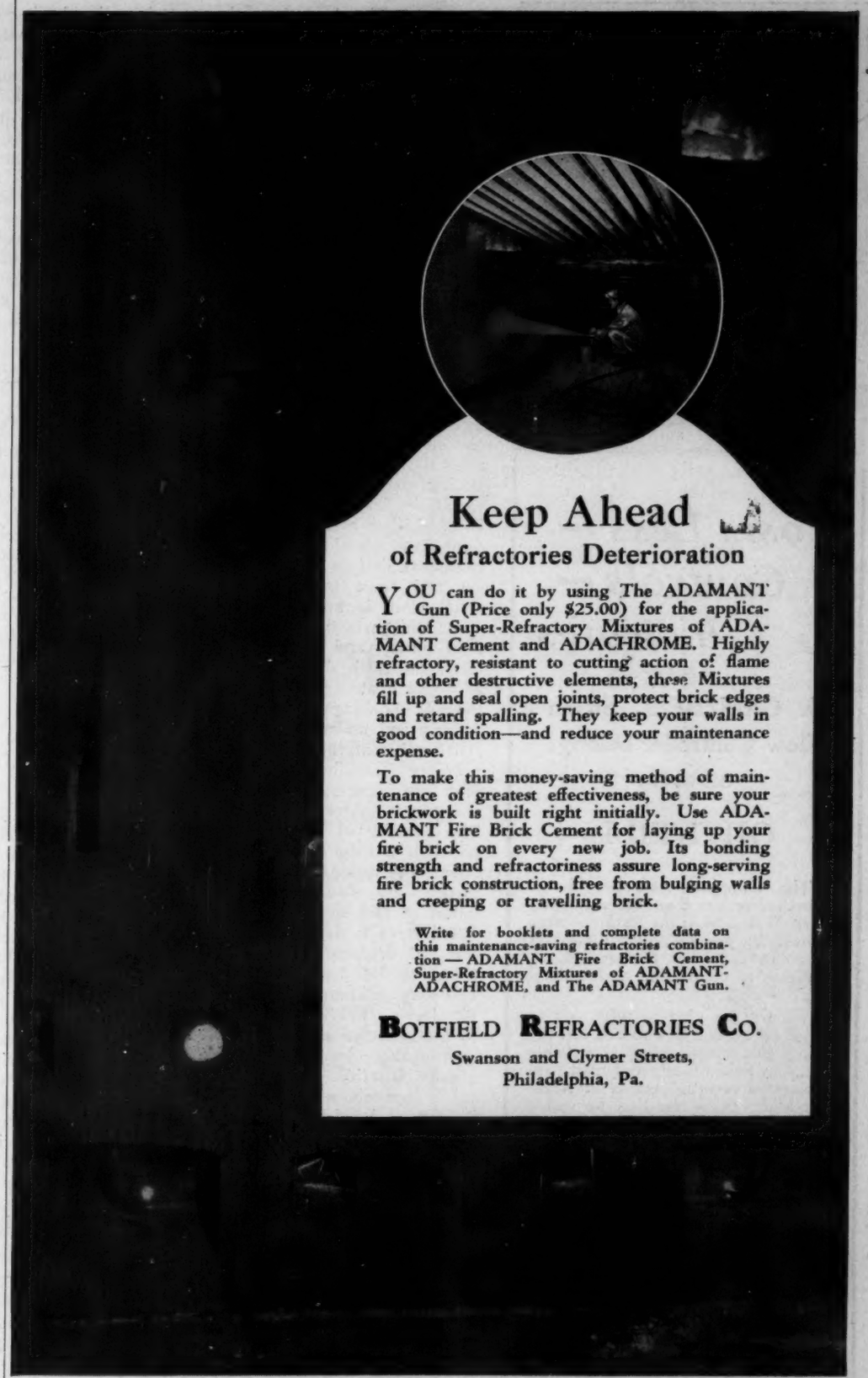

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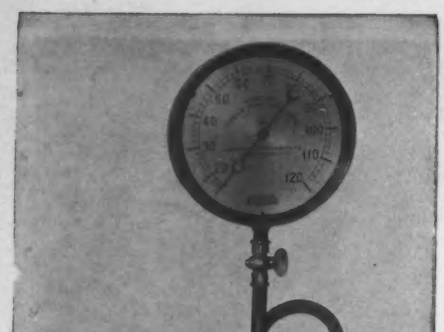

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the clay. The burned earth must be prevented from absorbing moisture. Burning capacity should be ample. Filter houses represent greater capital outlay than furnaces and should be allowed to stand idle as little as possible. There is a loss of probably 3-5 per cent of earth at every burn; the initial burn is accompanied by the highest loss owing to the presence of fines. It is in general considered better economy to discard an earth which has dropped to one-half its original filtering power; new earth will give greater production at less cost. Bucket elevators and belt conveyors have generally replaced the earth cart; pneumatic conveyors collect moisture, powder the earth, and are not generally successful. In general, the depth of a filter may be twice its diameter. There should be three good-sized heads, one on the top, one on the bottom and one on the side near the bottom, the last for the man pulling the filter. Bolts on all heads should be large, hard, and easily tightened. Either a small plate or a Fulton filter head should be used. The filter cloths, of burlaps and muslin, should be cut and sewn to fit exactly. Monel-metal cloth is now being experimented with; this would be more economical than burlap and muslin. For soaking filters the earth should first be as nearly as possible at the same temperature as the oil. Soaking may be from the bottom up and under pressure, with an air relief valve at the outlet. This method prevents channeling and in this way the filter can be completely filled with earth and run out through a plate in the head. The capacity of the earth is increased one-fifth and the run is better. Temperatures of soaking and running the oil through are about as follows: (a) solution of 600 stock and long residuum, 110 degrees to 114 degrees F., (b) neutrals 80 degrees to 95 degrees F., (c) 600 stock, 180 degrees to 225 degrees F., (d) long residuum stock, 120 degrees to 140 degrees F. The use of pressure, up to the point of agitating the earth, unquestionably increases efficiency over gravity filtration. The hand-manipulated valve formerly used in running a filter is being replaced by an orifice the size of which depends upon the character of the oil, the pressure used, the size of the filter, and the mesh of the earth. The oil from each filter should run to its own tank. An accurate record must be kept of the operation of every filter. Many plants are now dispensing with the rerun tank by pumping the stream which can no longer go to the finished tank on to a new filter just being soaked. Oil level should never be allowed to go below the surface of the earth while filtering is going on. In some cases the stream is diverted from the finished tank to the return line when it reaches the color which corresponds to the balance for the tank. The draining of a filter should be as rapid as possible and this is assisted by air pressure when it does not cause too much evaporation. Washing under pressure is also practiced and contributes to speed and efficiency; it also facilitates the elimination of fire risk. Clean gasoline having a high initial and low end point should be used. Washing is complete when gasoline coming through is clear and not greasy, though it may have a slight color. Some plants put the washings into the solution oil, others distill separately to avoid the risk of putting black oil into the green. The gasoline is sometimes alternated with very dry steam. It should be heated to within 75 points of its initial before being put upon the clay and this may be done by heat exchange with the steam coming from a filter. Heat loss in steaming filters is usually very high and methods for correcting this should be investigated.

* * *

OF PARTICULAR INTEREST TO THE CHEMIST

Testing and Analysis

Use of the Formolite Reaction for Testing Mineral Oils. Borodulin. (*Neftyanoye Khoz.* 14, 363-4 (1928). *C. A., Vol. 22, No. 12, p. 2262*). When the formolite precipitate is washed with water, the first part of the water is clear but gradually it becomes brown. This is attributed to the presence of ammonium sulfate, which is gradually washed out and the formolite is dissolved. Borodulin recommends the use of methylal, the methylal residue being soluble in chloroform.

* * *

RESULTS OF RESEARCH AND INVESTIGATIONAL WORK

Effect of Weathering on the Heat-Reflecting Efficiencies of Paints on Metal Tanks. Nelson and Jamieson. (*Ind. and Eng. Chem., Vol. 20, No. 7, pp. 702-705*). White or light-colored paints have been widely used to minimize heat absorption by exposed tanks. The effects of normal weathering on the efficiencies of various paints, applied on small steel tanks, were studied. Losses in heat reflecting efficiency ranging from 10 per cent to 60 per cent are indicated within one year. The tendency is to equalize the ranges from maximum day to minimum night temperature; these changes varying from 13 per cent to 65 per cent and following the same relative order as the losses in heat-reflecting efficiency. A gradually chalking white paint (sulfide fume-resistant type) retained its efficiency very well from both standpoints, in spite of an appreciable loss in brightness.

Northern Equipment Company, Erie, Pennsylvania, manufacturers of the Copes System of Boiler Feed Regulation, has appointed Don Allshouse as advertising manager. Mr. Allshouse comes to the Copes organization from Lamport, MacDonald Company, advertising agency of South Bend, Indiana. Prior to that, he was a member of the Department of Publicity of the Westinghouse Electric & Manufacturing Company, being located at different times at East Pittsburgh, Pennsylvania, Mansfield, Ohio and South Bend, Indiana.

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The Louis Allis Company, Milwaukee, Wisconsin, announces a self-ventilated, explosion-proof motor to be known as type Ex. It was developed to meet the need for a motor that would be small and light enough for practical use, and would also be explosion-proof.

The motor is said to be about half the weight of the non-ventilated type, but is slightly heavier than a standard open motor. A five horsepower, 1750 r.p.m type Ex motor, for instance, is only 38 pounds heavier than an open motor of the same rating and can be installed in the same space.

The Underwriters' Laboratories has approved the new motor for applications involving inflammable liquids equally or less hazardous than gasoline, naphtha, acetone and alcohol.

The motor can be mounted without special arrangements on a machine designed for a standard open type motor.

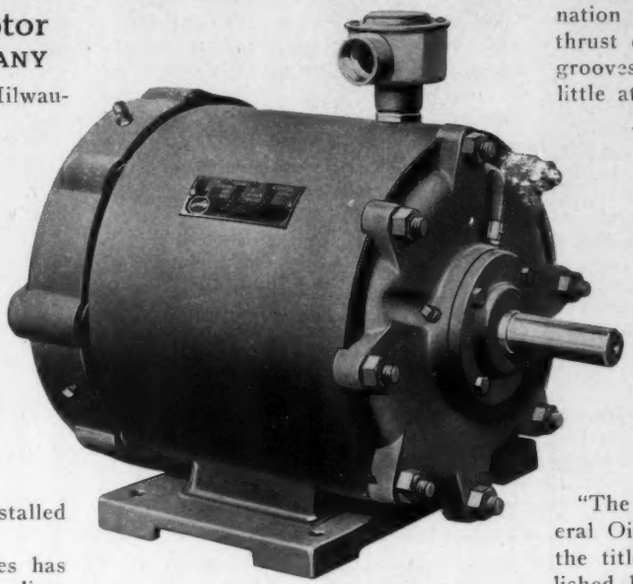
Sizes up to five horsepower are available now and a 10 horsepower type is to be announced soon.

More complete information may be secured upon application to the company.

The National Flue Cleaner Company, of Groveville, New Jersey, has recently appointed several new Southern representatives, as follows: Fuel Efficiency Engineering Company, American Trust Building, Birmingham, Alabama; A. S. Furtwangler, 4 South Broad Street, Charleston, South Carolina; Reed & Duecker, 171 North Main Street, Memphis, Tennessee; Buckmaster-Luck-Malochee, Industrial Homestead Building, New Orleans, Louisiana, and Henry Eggelhof, Construction Industries Building, Dallas, Texas. The above will act as exclusive distributors for the National Soot Blower which is designed for use with return tubular and Scotch Marine boilers.

"Oxwelded Industrial Piping," is a new item recently added to the Linde Library, publications of The Linde Air Products Company. It describes and explains economies in construction, repair and maintenance of oxwelded pipe systems and is profusely illustrated. Copies of this booklet may be obtained from The Linde Air Products Company, Room 401, 30 East 42nd Street, New York.

Manning, Maxwell & Moore, has purchased the entire manufacturing and selling business of the American



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It is the intention of Manning, Maxwell & Moore to pursue a liberal and constructive policy in research and development, particularly in connection with indicating and recording industrial instruments, which, in the past, have formed such an important part of American Schaeffer & Budenberg Corporation's success.

A. R. Martin has recently become associated with C. F. Braun & Company, manufacturers of heat exchangers and oil refining equipment. Mr. Martin will specialize on the design of complete refining units. He was for many years superintendent of the Tampico refinery of the Huasteca Petroleum Company, and more recently superintendent of the Destrahan refinery of the Mexican Petroleum Company.

Wagner Electric Corporation, 6400 Plymouth Avenue, St. Louis, has issued a new bulletin on Wagner Bearing Construction, in which the Wagner improved sleeve bearing and the Wagner ball bearing construction are fully described and illustrated.

Many improvements in bearing design are explained in this new bulletin. The improved Wagner sleeve bearings are sealed against the entrance of dust and dirt or the escape of oil, a combination of cork gaskets, wide rings, thrust collars, oil slingers and sealing grooves effect a bearing requiring very little attention.

The ball bearing construction used in Wagner motors is of the double cap type, a construction facilitating replacement of servicing, and makes it possible to remove or assemble ball bearings in dust laden atmosphere without danger of injurious foreign matter getting into the bearing.

Copies of the book may be secured by request to the company for Bulletin No. 156.

"The Internal Preservation of Mineral Oil Storage and Other Tanks" is the title of a new booklet just published by the International Compositions Company, Inc., 25 Broadway, New York. The booklet presents a complete description of "Rubshell," a paint for the internal surface of tankage. It is said that this paint is a mixture of synthetic gums into a varnish insoluble in any hydrocarbons or their condensations. "Rubshell" is produced in five different forms. Copies of the booklet may be obtained by request to the company.

A. J. L. HUTCHINSON

Research Engineer, who recently left the Standard Oil Company of California to go with the Engineering, Research & Equipment Company, Los Angeles and Dallas.

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Bulletin Notice

"The Elesco Superheater for Power Plants" is the title of a new booklet published by The Superheater Company, 17 East 42nd Street, New York.

In the first part are the introductory remarks giving brief statements about the company and its activities in the power plant field. The part played by superheated steam, basic definitions and briefly the advantages gained through the use of superheated steam, are also given. The next section, "Application of the Elesco Superheater," gives general descriptions of specifications for the 67 superheater and boiler arrangements illustrated. Design details are given in the next section. This is followed by an appendix reprinted in part from the seventh edition of Superheat Engineering Data. It discusses in greater detail the advantages of superheated steam, mentioned in the first part, and gives other data regarding the generation and use of superheated steam.

Convenient guides to the text, and superheater and boiler illustrations are given in the front of the book. An in- will be found at the back.

Copies of the booklet may be obtained from the company by request.

Union Roller Bearing Hoists are described completely in a new catalog published by the Union Manufacturing Company, New Britain, Connecticut. Copies of the catalog are available by request to the company.

In order to expedite the transaction of business on the West Coast, The Elliott Company of California has been organized as a branch of The Elliott Company, Jeanette, Pennsylvania. The California branch is managed by W. S. Elliott, president; F. A. Calmus, vice-president and general manager; and C. W. Moore, secretary and treasurer. Headquarters are at 813 Rialto Building, San Francisco.

Mr. Calmus was formerly the Elliott Company district manager in Kansas City. C. W. Moore has been on the engineering staff of the company for the past eight years and has been in California for 18 months.

W. A. S. Harmon has been placed in charge of another branch office in California, located at 528 Security Buildnig, Los Angeles.

The company has also recently made several appointments in connection with the Ridgway Works: H. A. Otterson has been appointed manager of the electric power department. This department will develop and handle such apparatus as generators for turbines, motor-generator sets, rotary converters, motors, etc.

E. A. Green is the new manager of the engine department, and R. C. Eccleston is now manager of the controller department.

D. A. Johann, having completed the year's apprenticeship course through the various shops and sales departments of the company, has been assigned as sales engineer in the New York district office.

W. A. Yost, an apprentice from North Carolina State College, has been assigned to duty in the turbine sales department, with headquarters at Jeannette.

Erie City Iron Works, Erie, Pennsylvania, has issued a bulletin under the title of "Some Fundamentals of Water Cooled Furnace Design," by W. J. Wohlenberg, M. S., M. E. The paper is well illustrated with drawings and gives a comprehensive treatment of the subject. Copies may be obtained by request to the company.

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